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annual report

ORIGINAL

To the Congress

Fiscal Year 1984

COMPLETED

CONGRESS OF THE UNITED STATES
Office of Technology Assessment
Washington, D.C. 20510

126

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Section I.—Statements by the Chairman and Vice Chairman of the Board, TAAC Chairman, and the Director of OTA

CHAIRMAN'S STATEMENT—CONGRESSMAN MORRIS K. UDALL

In the period of one decade, the Office of Technology Assessment has proved itself to be an influential organization in an international network of people and organizations who are concerned about the technical, social, and economic impact of a high-technology information society. OTA has proved its worth to its initial critics and it has more than gratified those of us who nurtured the agency through its early years.

During fiscal year 1984 the agency has helped Congress wrestle with such diverse subjects as postal zip codes, the causes and cures of airport delays, and the policy choices necessary for a useful space program.

VICE CHAIRMAN'S STATEMENT—SENATOR TED STEVENS

As we complete the 98th Congress it is apparent that Congress will continue to need technical analysis of issues which it will face in the coming year. Many of the issues which the 98th Congress faced will be revisited in the 99th Congress. These include: natural gas policy, clean air legislation and the problem of acid rain, and the cleanup of hazardous waste sites, just to name a few. These are in addition to the many budget and defense decisions which will have to be made—decisions which also include some technological considerations.

The incoming Congress will be closely examining all programs in the executive and the legislative branches to ensure that they are meeting the goals in the most efficient method possible. OTA should be able to assist in that process. Congress will also examine it along with the other congressional support agencies to ensure they are providing the type of information Congress requires to meet the new and changing demands facing our Nation.

TAAC CHAIRMAN'S STATEMENT—CHARLES N. KIMBALL

In the more than seven years that I have served on the Technology Assessment Advisory Council, OTA has grown from a small experimental agency to one with an international reputation for high-quality work. Under the leadership of the Technology Assessment Board and Dr. John Gibbons, the agency has attracted and retained a high calibre staff, and recruited many of the Nation's outstanding people to serve on advisory panels and participate in workshops.

With this annual report I will complete four years as Chairman of TAAC and am pleased to turn over leadership responsibilities to Dr. William J. Perry, managing partner of Hambrecht & Quist, Inc., of San Francisco, and former Under Secretary of Defense for Research and Engineering. The TAAC has also selected as Vice-Chairman Dr. David S. Potter, Vice President and Group Executive of General Motors Corp. and former Under Secretary of the Navy.

This year the Technology Assessment Advisory Council examined the utilization of OTA's work by Congress and the public. We believe that congressional confidence in OTA's ability was reiterated when it assigned the Office the task of selecting the members of the Prospective Payment Commission and responsibility for overseeing the Commission, as mandated by the Social Security Amendments of 1983.

The Council also met with the staff of OTA's program areas to talk about how they plan their work. We found that these programs are paying the price of their success in being useful to Congress. Over the past several years there has been a steady increase in the number of committees served, and in request for full assessments, short responses and special analyses. Studies required by legislation are having a significant impact on the OTA staff's ability to plan ahead and schedule work within the program areas. TAAC urged OTA to expend greater effort to minimize the number of such mandated studies and to cooperate with other congressional agencies in so doing.

OTA has now proved its ability to provide critical and helpful analysis of tough technical issues that concern Congress. In view of this success, TAAC believes that OTA may want to increase the number of studies involving broad national issues. Members of TAAC also believe that OTA should draw on its past and ongoing assessments to provide Congress with broader strategic advice on important national and international issues. For example, they suggested that OTA incorporate insights from its extensive experience in energy technology analysis to complete a broad assessment of the kind of energy policy issues that are likely to be serious over the next decade. They also suggested that OTA assess several broad strategic approaches to health policy.

In summary, OTA has moved out of its initial survival stages and is regarded far and wide as an agency of competence and respect. I am pleased to have been associated with it during this process.

DIRECTOR'S STATEMENT—JOHN H. GIBBONS

In my past career as an experimental physicist, I could give a direct and unambiguous answer to the question, "How are things going?" Sometimes I'd have to give a rather disappointing response; on other occasions the response was honestly enthusiastic. But it was a rare occasion when I didn't have a well-defined basis for my reply. When that same question is asked of me as OTA's Director, I have to think a lot longer before deciding how to respond, because the work at OTA—and the measure of its progress—is much more complicated. Nevertheless, it's a fair question, important to address periodically. After five years as Director of OTA, I am pleased to write about that question in this report to Congress.

OTA is in the midst of some of the thorniest technical issues before Congress. The fact that it is contributing to these debates is one of the best indications of "how OTA is doing." As it has grown in capability and trust, OTA has moved from the periphery of the hot issues into the center of most of those that involve technology.

The breadth of the congressional agenda linked to technology is overwhelming. While many of OTA's peers in academia and industry despair at the thought of doing meaningful analysis on so many issues within the short time available to us, Members and staff of Congress, who must deal with far more encompassing issues and even shorter times, often wonder why OTA seems to need so *much* time. Thus OTA plays an intermediary role—between the perspectives of different stakeholders in private and public sectors, and between levels of detail. We must dig into the finer points of an issue in order to synthesize, integrate and translate issues in terms of necessarily broad public policy decisions.

The current pace of developments in science and technology is astonishing, and may be accelerating. For example, recent progress in science stretches from the megascale of understanding the universe, the Sun, and the planet Earth, to the microscale of elementary particles, crystals, exotic solids, and "living" molecules. These features seem to stand out: *First*, the participants in this grand adventure now span the globe; simultaneous, independent discovery by researchers in different countries is now commonplace. The United States no longer dominates the field. It competes for leadership and is successfully challenged in numerous fields. This situation is not all bad, for it creates opportunities for the United States to learn as well as teach in the international domain. *Second*, the rate at which many of the advances in basic science are successfully converted to technology has never been faster, and this is particularly the case in the United States and Japan. *Third*, this rapid

conversion of knowledge into technology reinforces the great dilemma—virtually all powerful new ideas can (and usually will) be used for both constructive and destructive purposes. For example, the same computer and electronics technology used to dramatically improve medical diagnosis or to help save billions of barrels of oil each year can be used by a criminal to steal large sums of money or divert private information on individuals which can threaten our basic liberties.

The complexity of society—the degree of interdependence between people; the extent to which the "commons," such as air and water, are used; population density; rate of introduction of new chemicals and forms of life; etc.—is also expanding around the globe. It therefore may be that the governance to ensure freedom, justice, and care for the environment needs even greater insight in the future. Little wonder, then, that the U.S. Congress is under constant pressure to deal with the growing number of policy issues related to science and technology.

The process of decisionmaking becomes particularly confusing when the technical experts disagree. Most key questions of policy are, however, largely trans-scientific, not satisfied by purely technical answers. Analysis can reveal the technical or economic impacts of a particular course of action, but understanding the social and cultural impacts, the most value-laden dimensions of major issues, requires interpretation of that analysis, the most difficult part of our legislators' jobs. OTA was created, in part, to provide an in-house, nonpartisan source of expertise for all committees so that conflicting views might be understood. Thus OTA tries to set the facts straight, illuminate areas where strong consensus exists, and to explain where and why knowledgeable experts disagree. When it works, that process raises the level of the policy debate. Analysis will continue as long as the issue is unresolved.

Criteria to measure success in OTA's business are not as definitive as the marketplace is for industry, or peer recognition is for scientific research. But there are some figures of merit that stand out in evaluating OTA's progress: How relevant to Congress are the issues being addressed? How accurate, comprehensive, and nonpartisan is the analysis? How helpful is the content of the findings? How timely are the results? Responses to these questions can be interpreted from the strong interest shown by Committees and Members (we served over 64 committees and subcommittees in fiscal year 1984); resources provided OTA to support its work (143 slots and $14.65 million were appropriated for fiscal year 1984); requests for testimony and briefings (more than 75 in fiscal year 1984); active support from the private sector, academia, and public interest groups (about 1,200 noncongressional experts helped OTA in fiscal year 1984); and intense interest from a growing number of foreign governments (in fiscal year 1984 we had high level visits from 23 different nations).

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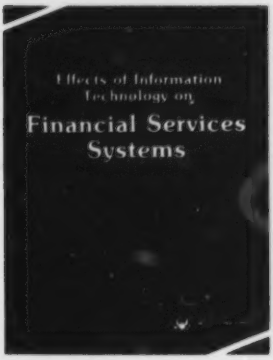
By these measures OTA seems to be doing fine. We understand that we must—and should—earn our keep year-by-year. But it is particularly gratifying that OTA is being utilized by such a diversity of committees and that so much international attention seems to be focusing on this small congressional investment in improving its understanding of complex issues and opportunities in technology.

Section II.—Year in Review

The assessments carried out by OTA cover a wide spectrum of major issues that Congress and the country are facing. A brief summary of each report published by the Office during the year* is presented in this section. The reader is cautioned that these are synopses of reports. They do not cover the full range of options considered or all of the findings presented in any individual report.

Effects of Information Technology on Financial Service Systems

Information processing and communication technologies, together with consumer response and economic, legal, and regulatory factors, have dramatically transformed the financial service industry in the last 10 years and challenged the premises of current Federal policies rooted in the 1930's.



Today's financial service industry and its competitive structure differs markedly from that of the 1970's, and is expected to continue changing at a significant rate at least through this decade. Reliance on advancing technologies to deliver services and products such as credit, deposit-taking, investment, and insurance, has increased rapidly. Even the smallest firms can afford the key technologies and can compete with larger firms in providing sophisticated services.

Automated teller machine networks have reduced the significance of geographic restrictions on the operations of banks, and have offered opportunities for new entrants, such as food and merchandise retailers, to the financial services industry. Systems providing access to funds from virtually any place in the Nation, regardless of where they are deposited, are now being developed and are likely to be in use in the next few years. They will be based on advanced communication technologies including satellite relays, video cable, fiber optics and cellular radio.

Banks, savings and loan associations, and credit unions probably will concentrate on processing transactions and place less emphasis on gathering deposits and providing financing. In the future, branches will

*Fiscal year 1984 (October 1983 to September 1984).

be dominated by a variety of machines, with institutional personnel serving more of an advisory role than actually handling customer transactions. Many financial services will be delivered to customers at convenient locations, possibly on their business or home terminals, with little need for visiting a provider's office.

The rapid transformation of the structure of the financial service industry raises significant questions for Congress about whether much of present public policy will be relevant and appropriate for an increasingly automated industry. Although fundamental policy objectives such as fostering institutional stability and integrity or protecting consumers may remain the same as in the past, the focus of future regulation may well have to be different.

Policies that assume a specific structure of the industry or service mix seem to be particularly vulnerable to unanticipated effects when new technologies are introduced. For example, the assumption that only banks would take deposits, and thus need regulation to protect depositors, was undermined when firms other than banks used technology to offer similar services such as money market accounts.

Changes in the financial service industry will both benefit consumers and create problems for them. New delivery systems are designed to be more convenient, but consumers will have to be better informed to understand and to choose among the wider range of available options and services. Because financial service providers can now use price as an instrument for competition, more and more services will be priced explicitly. Consumers may be offered an increasing range of choice and pay only for services used.

Though consumers may not perceive differences between the offerings of various financial service providers, the existing legal/regulatory structure does not always cover the activities of nontraditional providers. These unregulated services often do not provide the same protections to consumers.

Public policy issues stemming from the changing nature of the financial services industry involve access to services, system security, privacy, and effects of fundamental changes now under way in the telecommunications industry.

Despite broader choices for most consumers, some may find their options more constrained. For example, pressures for electronically transmitting payrolls directly into deposit accounts and the increasing role of the credit card as evidence of financial responsibility are making it difficult for individuals to avoid interaction with a financial service institution. Yet, some people prefer not to deal with financial institutions altogether, and others have not been accepted as customers. Lack of access to some electronic financial services may implicitly limit or deny access to other goods and services. Over the long run, guaranteed access to some minimal level of financial services may be essential for all people.

Increasing use of electronic systems for delivering financial services heightens potential threats to individual privacy. Existing law provides some protection from intrusion on financial data by the Federal Government, but virtually none from the use of this information by States and local governments or private parties and organizations. In addition, the privacy policies of some other countries are more stringent than those of the United States. Restrictions on international transmission of data could lead to problems for American financial service firms doing business overseas.

Recognition of the problems of system security and integrity is becoming more widespread. It is clear that providers of financial services have become so heavily dependent on information processing and telecommunication technologies that the failure of automated systems under some circumstances could be very serious. However, the true magnitude of security problems is not known, and additional information is needed before developing public policy alternatives.

Because telecommunications is a key component of financial service delivery, fundamental changes now under way in the telecommunications industry will directly affect the price and the mix of financial services that will be offered.

Technology Transfer to the Middle East

The report examines advanced technology transfers in five sectors (petrochemical production, commercial aircraft support systems, nuclear power, medical services, and telecommunications) to six Islamic countries in the Middle East (Algeria, Egypt, Iran, Iraq, Kuwait, and Saudi Arabia). The U.S. portion of the Middle East market for advanced technology equipment and services is more likely to shrink than expand, although U.S. companies have maintained about 20 percent of the machinery and equipment market over the past 10 years. Middle Eastern buyers have in some cases developed the capability to operate and maintain imported advanced civilian technologies, but in most cases they have not yet significantly adapted or developed these technologies.

Technology transfer: Although the experiences of the Middle Eastern countries differ widely, all of them have faced significant problems in effectively utilizing new technologies. Some success is seen in the efficient operation of commercial aircraft by local workers, but technology absorption has been much more limited in the petrochemical and nuclear sectors. Middle Eastern countries have attempted to im-

prove their ability to utilize and bargain for imported technology through policies that regulate business activities and develop local technical skills.

Technology trade: The value of machinery and equipment exported by industrial countries to the Middle East increased from $2.2 billion in 1970 to about $42 billion in 1982, an eightfold rise in dollars of constant purchasing power. Western European and Japanese firms are strong competitors with U.S. firms. Japan increased its share from 9 percent in 1970 to 23 percent in 1980, while West Germany maintained a share of approximately one-fifth of the market and France saw its share decline from 18 to 9 percent during the period.

Not only has the era of explosive growth in technology trade with the region ended, but the U.S. share is also likely to decline for several reasons. U.S. trade, which is centered on Egypt and Saudi Arabia, could be adversely affected by the end of megaprojects, decisions by recipients to diversify suppliers, expanded U.S. export restrictions, or increased export subsidization by other suppliers. The factors most strongly influencing contract awards are the strategies of the firms supplying technology, but policies of supplier governments (including financing, export controls, and economic assistance) have also been important in some cases.

Policy Options: Future prospects for U.S. technology trade depend in part on choices facing U.S. policymakers. In the United States, tension between commercial and political interests has precluded the formulation of a consistent approach to civilian technology transfer. Japan and some West European countries have emphasized economic interests in their policies, which have generally supported technology trade with the Middle East.

If U.S. policymakers decide to establish more consistent policies, a number of approaches could be considered: 1) denying and providing technology selectively in order to achieve political goals, 2) decoupling commercial technology trade from political interests, and 3) promoting commercial technology transfer.

If export controls on civilian technologies are expanded, potential customers may be pushed toward other suppliers. But comprehensive promotion of technology transfers would require considerable government support. In order to establish a more consistent approach, policymakers would have to carefully balance commercial, economic assistance, and political/strategic aims.

Major findings concerning technology transfer in the five sectors follow.

1) Petrochemical production—The Gulf States, with inexpensive feedstocks and state-of-the-art technology, will be major petrochemicals producers by 1990. Their exports are expected to account for ap-

proximately 20 percent of commodity chemicals traded worldwide. Western Europe and Japan will be most affected by the shifts in the worldwide market, but U.S. firms can adjust by concentrating on production of specialty and second-tier products.

2) Nuclear power—No nuclear power reactors are currently operating in the Middle East, nor are there likely to be any in operation before the 1990s. The availability of hydrocarbons for power production and the small size of electricity grids are among the factors limiting nuclear power development in the region. Most of these countries have not committed themselves to nuclear power programs.

No Islamic country in the Middle East is likely to have the capability to develop nuclear weapons on a wholly indigenous basis before 1990, and most would find it impossible to do so before the turn of the century. Proliferation of nuclear weapons would be most likely to occur through the use of research reactors and small-scale enrichment and reprocessing facilities to produce small amounts of weapons-grade materials over a long period of time. Only a few have obtained sensitive facilities which could be used to build nuclear weapons. In the decade ahead, the prospects for nuclear proliferation will increase, as indigenous capabilities are improved and as new suppliers who are not parties to the Nuclear Nonproliferation Treaty enter the market.

3) Medical services—U.S. firms have been major suppliers of hospital management in Saudi Arabia, winning a 70-percent share of the $500 million market in 1981. U.S. firms have also been important suppliers of medical equipment throughout the region. Yet, in the future, the market share of U.S. firms in medical equipment may shrink unless improvements are made in after-the-sale service. While hospital management will remain important in Saudi Arabia, the most pressing needs in the Middle East will be for preventive and less-sophisticated health care. AID health projects have contributed to improvements in Egyptian health standards; programs providing specialized training and retraining of medical personnel are needed throughout the region.

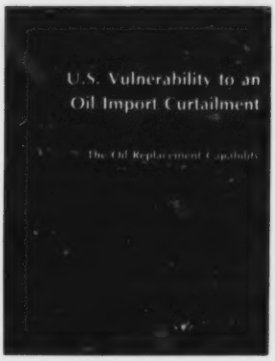
4) Commercial aircraft support systems—Technology absorption has been comparatively extensive in this sector, as shown by the operating statistics (including safety) of Middle Eastern airlines, which remain on a par with major international airlines while local personnel assume more functions. Sales of commercial aircraft and parts in the Middle East were valued at over $1.8 billion in 1982. These sales often determine the award of follow-up contracts for parts and service. Sales of U.S. aircraft in particular have been limited by U.S. foreign policy export controls.

5) Telecommunications—More than $3 billion in telecommunications equipment has been sold in the Middle East annually, and Japan became the major supplier by 1980. While U.S. firms have been major suppliers

of advanced technologies such as satellite and multiplex equipment, firms from Western Europe and Japan have provided most of the telephone and telex systems, which have been the central focus of Middle Eastern telecommunication expansion. Demand for telecommunications equipment and services will continue to grow, as seen in cooperation in Arabsat, a regional satellite telecommunications system.

U.S. Vulnerability to an Oil Import Curtailment: The Oil Replacement Capability

If a large and protracted U.S. oil supply shortfall begins within the next few years, the United States has the technical and manufacturing capability to replace up to 3.6 million barrels per day (MMB/D) of oil with other energy supply and demand technologies within 5 years after the onset of the shortfall. This conclusion is based on OTA's analysis of current manufacturing capacities and technical end-user constraints, as well as peak historical rates for installing various energy technologies; and it assumes a pre-shortfall oil demand of about 16 MMB/D. (Current U.S. oil demand is 15.8 MMB/D, of which 4.8 MMB/D are net imports.)



Currently available technologies that can replace the largest amounts of oil are those that: 1) increase the efficiency of, and substitute alternative fuels for, oil used for space and water heating, and steam production; and 2) increase, through replacement of existing vehicles, the average fuel efficiency of automobiles and light trucks on the road. The fuel substitution would require, annually, about 2 trillion cubic feet of natural gas and 115 million tons of solid fuels (coal and wood) at the end of the 5 years. All of the added natural gas can be made available through increased efficiency of natural gas use in buildings and industry.

A large and enduring shortfall and oil price increase would have severe economic consequences for the United States, even with full drawdown of the Strategic Petroleum Reserve and available private oil stocks. The magnitude of the economic impacts of an oil shortfall, however, would vary substantially with the rate of investment in oil replacement technologies. Analysis of a shortfall that reduces U.S. oil supplies by 3 MMB/D indicates that if all of the lost oil were replaced over the 5-year period after a shortfall begins, the decline in the gross national product would be 40 percent less than if only half of it were replaced in that time. Further, employment losses would be 30 percent less and oil price increases about half as much with the more rapid rate of replacement as compared to the slower rate. In other words, to the ex-

tent that the lost oil is not replaced through investments in replacement technologies, oil consumption must be lowered through reduced economic activity and personal consumption.

If the economy remains relatively stable and strong, rapidly rising oil prices following onset of a shortfall could provide sufficient incentive to invest in oil replacement technologies at the maximum rate. A stable, strong economy lowers the risk and increases the profitability of such investments, and faster oil replacement improves prospects for stability and growth of the economy. However, any number of factors—investor uncertainty about future oil supplies and economic conditions, capital shortages, unfamiliarity with alternative fuels technologies, price controls on natural gas, etc.—could limit these investments.

In view of the uncertainties about the market response to an oil shortfall, the importance of a stable economy and the difference in economic impacts associated with a rapid versus a slower response, it may be necessary to stimulate investments in oil replacement technologies in order to minimize the economic damage resulting from a shortfall. Although rapid deployment could be achieved without government-mandated conversion of production facilities to supply the oil replacement technologies, advanced planning by Federal and State governments is necessary. A system to monitor directly the rate of investment in oil replacement technologies and the quantity of oil replaced also would have to be established and functioning prior to the onset of a shortfall.

A variety of incentives ranging from information and technical assistance, to economic incentives and regulation could be used, as needed, to stimulate investment. Economic regulations that inhibit investment in replacement technologies (e.g., electric utility fuel adjustment clauses and certain price controls) may also have to be removed or modified. For these measures to be most effective, however, a decision would have to be made at the highest level that the Government will intervene if the market is overly cautious. Uncertainty must be removed from the investment climate, and clear signals about the need for investment would be required.

In the longer term, declining domestic oil production, accompanied by an expected shift away from oil uses for stationary direct heat, will increase the Nation's vulnerability to an oil shortfall. This will occur even if all stationary uses of fuel oil are replaced by alternative fuels and conservation because the decline in domestic oil production is expected to occur at an even greater rate. Only by relying more heavily on coal and biomass for chemical feedstocks, increasing efficiency of natural gas use and in all modes of transportation, and producing synthetic transportation fuels in addition to accelerating the replacement and conservation of stationary uses of oil, can the Nation expect to significantly reduce its vulnerability to an oil shortfall over the next few decades.

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Airport System Development

Events in recent years—airline deregulation, the air traffic controllers' strike, and the growth of air travel in a resurgent economy—have focused attention on problems of airport capacity. Lack of capacity at major airports, notably during peak travel periods and adverse weather, has been cited as a significant cause of delay and rising costs in providing air service.

Airlines and other users of major airports have called on the Federal Aviation Administration and local airport authorities for relief of immediate problems and assurance that adequate facilities will be available to accommodate long-term growth in air travel. The OTA study examines technological, economic, and managerial approaches that could be taken to increase capacity and reduce delay at airports.

Technological methods to augment airport runway capacity include: 1) more accurate radar for use in terminal areas, 2) more precise guidance for landing in reduced visibility, 3) improved air traffic control systems to smooth and regulate traffic flow, and 4) methods to detect and monitor wind shear and wake turbulence.

These technologies, especially if coupled with reduced aircraft separation standards and revised rules for use of multiple runways, could increase capacity by as much as 30 percent at some airports during adverse weather, when the rate of operations is reduced from that attainable in good visibility. Benefits would vary considerably from site to site since they depend on airspace geometry, runway layout, traffic mix, and prevailing weather conditions. On average, the increase in capacity is likely to be much smaller, probably in the range of 5 to 10 percent. These increases should not be dismissed as insignificant; they would lessen delay where and when it is most likely to occur—at major airports in bad weather—and so would benefit a large number of passengers.

Another approach would be to build new airports to absorb growing demand. In most cities, however, this is impractical because of scarcity of land, high costs of development, and community concern about noise and land use. OTA found no metropolitan area actively planning to build a major new airport, and it is unlikely that more than one or two such airports will be built before the end of the century.

Building new facilities and developing new guidance and control systems are becoming increasingly difficult and yield diminishing capacity gains. Adequate future capacity cannot be assured by technology

alone, and it is important to explore approaches that make more effective use of what is already in place—selectively upgrading existing facilities and exploiting surplus capacity at other nearby airports in the region. Two promising solutions of this sort are separate short runways for small aircraft at major air carrier airports and "reliever" airports for general aviation at convenient locations elsewhere in the metropolitan area.

Much of the delay at airports stems from overscheduling of airline flights in morning and early evening hours and the tendency of general aviation to concentrate at these same times. Building new facilities to accommodate these high peaks of demand is often self-defeating since the additional capacity simply results in more peak-period demand and creates the need for more, increasingly expensive, capital investment. An alternative, less capital-intensive, approach is demand management to alter patterns of airport use so that demand can be accommodated within existing capacity.

Two basic methods can be used to manage demand: 1) setting landing fees according to the time of day or level of demand, and 2) regulatory or administrative actions to limit the number or type of flights that will be accommodated. Either approach would have the same general effect—demand would be spread more evenly throughout the day, thereby eliminating costly investments in facilities needed only at peak periods, but idle the rest of the time.

Delay on the landside—in the terminal building and on roads leading to the airport—is as common as airside delay, and equally costly and inconvenient to passengers. In general, the solution to landside problems is not new technology, but better planning and coordination among the various Federal, State, and local agencies, which often have overlapping jurisdictions and conflicting priorities.

In cooperation with the Congressional Budget Office, OTA examined the financial condition of U.S. airports and found few funding problems at the top 71 airports that collectively serve over 90 percent of airline passenger traffic. These airports are in good financial condition and enjoy sufficient, often ample, revenues to assure their creditworthiness in the municipal bond market. There has never been a default on an airport bond issue—an unblemished record that further enhances airports' reputation as soundly financed and managed enterprises. Availability of capital for improvement at major airports is not a significant obstacle, and the locations facing the greatest problems of congestion and delay appear able to finance needed capital investments with only minimal Federal support.

The major issues surrounding the current Federal role in airport development concern the level and purpose of capital grants to airports, the criteria of eligibility, and the administration of the program. As alternatives to present policy, OTA examines various ways to retarget Fed-

eral funds and to shift some administrative and fiscal responsibility for airport improvement programs to the State and local levels.

OTA also addresses the question of Federal, State, and local airport planning and provides background information to help evaluate the National Plan of Integrated Airport Systems, to be issued by the Federal Aviation Administration in September 1984. The major finding with regard to planning is that there is a need to look at airports from a regional and multimodal perspective, seeking ways to weld them into the overall transportation network. This entails balancing the use of regional airport facilities, reducing the cost and inconvenience of access to airports from within the metropolitan area, and promoting better connection between air and land modes of transportation.

Technology, Innovation, and Regional Economic Development

High-technology industry is so difficult to define, and so interdependent with other sectors of the economy, that to define Federal policy for regional development based on distinctions between "high technology" and other sectors would be artificial and possibly misleading. High-technology industries are expected to grow somewhat faster than overall employment over the next 10 years, but because of their relatively small employment base they will directly account for only a small fraction of total employment growth. Their largest employment impacts are likely to come through the diffusion and widespread application of their products by other industries, "smokestack" and services alike.

High-technology industries are more significant from the local perspective because of their impacts on employment and development in particular communities. Over the past 10 or 20 years a few regions, notably California's Silicon Valley and Massachusetts' Route 128, have developed strong local economies based on concentrations of microelectronics and computer firms. Today's high-technology industries seem to be spreading more widely across the Nation, and new development opportunities are being opened by advances in emerging technologies like robotics and biotechnology. Moreover, advanced manufacturing technologies are creating new opportunities for basic industries and the regions where they are concentrated.

The growing competition for high-technology industries has generated hundreds of initiatives by State and local governments, universities, and private sector organizations. These groups see their high-

technology efforts as logical extensions of traditional economic development activities. Most of the programs are designed to encourage technological innovation and local business development, by mobilizing resources or removing barriers in six general areas:

- research, development, and technology transfer;
- human capital, including education and training;
- entrepreneurship training and assistance;
- financial capital;
- physical capital; and
- information gathering and dissemination.

These initiatives are too recent and too varied to evaluate systematically, but in many regions they have resulted in new linkages between government, university, and industry. Experience suggests that these initiatives are more likely to succeed if they build on existing industries and available resources. For most communities, the greatest opportunities may lie in encouraging business development and technological innovation from within, rather than trying to attract high-technology businesses from other regions. From a national perspective, these State and local efforts may also contribute to the productivity and competitiveness of the entire U.S. economy if they can increase the national level of R&D or quicken the pace of commercialization and diffusion of new technologies.

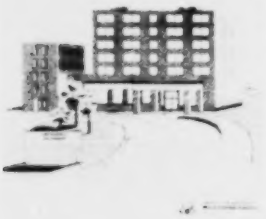
Federal policies have contributed to State and local high-technology initiatives in the past, usually as an indirect result of attempts to achieve broader national goals and purposes. For example, innovation-oriented policies—those intended to promote R&D and technological change at the national level—often have significant impacts on economic development in particular regions. Similarly, community and economic development programs—such as block grants, business assistance, and education and training programs—have sometimes provided the resources for innovative State and local initiatives. Recent changes in Federal policy, such as the treatment of capital gains and joint venture R&D, promise to create a better climate for regional high-technology initiatives.

OTA finds no compelling evidence that an extensive new Federal effort, specifically targeted on this aspect of economic development, would be necessary to promote regional high-technology development. However, changes that have been proposed to achieve broader national objectives might provide additional indirect benefits to the extent that they increase Federal awareness of and support for State and local efforts. Better information about the regional impacts of Federal programs, the effectiveness of State and local initiatives, and the regional implications of technological change would be useful to Federal, State, and local groups alike. Improved coordination, among existing Federal programs and with State and local mechanisms, would also be effective in promoting innovation and economic growth through regional high-technology development.

Medical Technology and Costs of the Medicare Program

The use of medical technologies, such as drugs, devices, and medical and surgical procedures, has significantly affected Medicare costs. Payments for each enrollee rose 107 percent between 1977 and 1982 —an average of 19 percent per year. Although inflation is primarily responsible, nearly one-third of the increase is related to medical technology—both from expanded use of services (25 percent) and from increases in medical prices above the general inflation rate (3 percent).

Medical Technology and Costs of
THE MEDICARE PROGRAM



An important influence on the adoption and use of medical technologies is the Medicare program itself, in part because of its size and scope and in part because other third-party payers often follow its example. Thus, changes in Medicare policies could restrain the growth in Medicare costs by influencing the adoption and use of medical technology.

OTA presents Medicare policy options for Congress in four areas: 1) coverage of specific technologies; 2) payment to hospitals; 3) payment to physicians; and 4) approaches to changing incentives, for the adoption and use of technologies, that do not directly involve Medicare payment (e.g., encouraging the development of alternative cost-effective health care delivery systems).

Medicare's coverage policy for specific technologies can influence hospitals' decisions about purchasing expensive medical technologies such as diagnostic imaging equipment. Costs could be contained by limiting coverage for certain technologies to selected providers or sites; considering cost as a factor in coverage decisions; providing interim coverage in exchange for data on efficacy, safety, and costs of emerging technologies; and improving the implementation by Medicare contractors of national coverage decisions.

Changing coverage policy alone is likely to be of limited value in containing Medicare costs, because of the large number of medical technologies being developed or used and the decentralized administration of the Medicare program.

Medicare's hospital and physician payment policies have more impact on the adoption and use of medical technologies than its other policies. From 1966 until 1983, Medicare operated under a retrospective, cost-based reimbursement system which provided little incentive for hospitals to limit expenditures on medical technology.

The hospital payment system was significantly changed by the Social Security Amendments of 1983 (Public Law 98-21) which established a prospective, per case hospital payment system based on Diagnosis Related Groups (DRGs). With DRG payment, hospitals receive a specific amount of money for each patient, based on diagnosis, regardless of the amount or type of services the patient receives.

Four possible changes in Medicare hospital payment, not mutually exclusive, include: the use of alternative prospective payment methods and modifications of the DRG system; changes in capital payment methods; contracting with selected hospitals; and increased patient cost-sharing for hospital services.

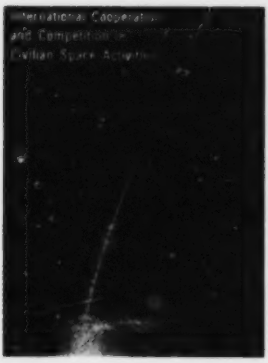
Thus far, Medicare's DRG payment system extends to inpatient operating costs alone, and capital costs continue to be reimbursed on a cost basis. Continuing this method of capital payment provides an incentive for hospitals to adopt expensive equipment that reduces operating costs even though the total cost per case may be greater.

Any cost-containment effort must acknowledge that individual physicians play a central role in determining what services are provided to patients in hospitals and other settings. Medicare payment methods can influence physicians' incentives for the use of medical technologies. Two possible changes are: adopting fee schedules or caps on physician payments; and requiring beneficiaries to assume more of their health care costs, either by increasing cost-sharing or reducing the types of benefits that Medicare will cover. Changing Medicare's assignment policy, which currently allows physicians to decide whether to accept Medicare payment as full payment, would strengthen the implementation of the other changes, although it might discourage some physicians from treating Medicare patients.

Alternative approaches to encourage the appropriate adoption and use of medical technologies, and ultimately save costs, include two general policy mechanisms: fostering competitive behavior by providers; and administrative changes in Medicare (e.g., merging Medicare's programs for hospital insurance and for supplementary medical insurance). For example, policies that encourage the use of alternative sites of health care delivery stimulate competition.

International Cooperation and Competition in Civilian Space Activities*

The space programs of Western Europe and Japan have made enormous technical and organizational advances over the last decade, but the United States has not fully adapted to these changes. In addition, the U.S. Government has not effectively involved private investment in space, except in satellite communications.



Changing conditions in the political, economic, and technical aspects of civilian international space activities raise four major concerns for Congress:

International competitiveness in space technologies: Although the United States still leads in space research and development, Western Europe and Japan are marketing space-related goods and services in direct competition with the United States. Among other items, Western Europe has developed the Ariane launch vehicle and the SPOT land remote sensing system. Japan competes in selling ground stations for satellites, and is developing an ocean remote sensing system.

Role of the U.S. private sector: High capital cost and high technological and economic risk inhibit private investment in space. If future Government policies are well-designed to foster private sector commercialization of space technology, market developments could lead to a wide array of commercial space applications by the 1990s.

Access of U.S. firms to international markets: Large parts of the international market for satellite communications equipment and virtually all of the international market for services are closed to international competition. Where open competition exists, U.S. technology continues to dominate the market.

Efficacy of U.S. participation in international cooperative space projects: U.S. cooperative space projects continue to serve important political goals of supporting global economic growth and open access to information, and increasing U.S. prestige. Such cooperation should continue to involve the developing countries, especially because they are becoming a significant market for space-related goods and services.

*Summary completed July 1984; full report will be published early 1985.

OTA examined space science and several space technologies at different stages of Government operational status or commercial development:

- **Space Science**—Cooperation in space science continues to be a major source of cultural, economic, political, and social benefits for the United States. However, the major driving force behind cooperation is the prospect of sharing costs. Although the United States leads generally in space science, it will face increased competition in certain subfields from the European Space Agency (ESA), Japan, and the U.S.S.R. Because of limited resources, the United States must remain cooperative in space science to remain competitive.
- **Space Transportation**—The entry of ESA's Ariane booster into the international launch vehicle market, and the U.S. private sector's interest in selling launch services, require the U.S. Government to reassess its traditional role as sole provider of launch services. Current pricing policy for the Shuttle discourages competition from the U.S. private sector launch industry. Yet, raising prices might discourage the private development of manufacturing or other uses of space.
- **Satellite Communications**—Since private investment dominates this sector, issues of economic regulation and international trade are paramount. The U.S. Government must decide whether to allow U.S. firms to own transatlantic communications satellites independent of INTELSAT;* how vigorously to support the entrance of the U.S. firms into overseas service and equipment markets; how much to spend on research and development to keep U.S. communications satellite technology competitive; and how best to further U.S. telecommunications and foreign policy objectives at the International Telecommunication Union's 1985 ORB'85 meeting on the geostationary orbit.
- **Remote Sensing From Space**—By 1990, Canada, ESA, France, Japan, and perhaps the Soviet Union expect to deploy ocean or land remote sensing systems. The United States may increase its competitiveness in land remote sensing by transferring Landsat to private hands. However, successful transfer will require a sizable subsidy until a sufficient data market emerges. Joint construction of an international polar orbiting meteorological satellite system with other countries may be desirable.

*International Satellite Communications Organization.

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- **Materials Processing in Space**—More basic and applied research is needed to determine the economic feasibility of manufacturing commercial products in space. Until international commercial competition arises, Europe and Japan should be viewed as valuable partners for international cooperation in materials processing research.

As the U.S. private sector becomes more involved in space activities, several Government agencies in addition to the National Aeronautics and Space Administration (NASA) will have a broader role to play in the overall direction of the Nation's space policy. NASA, by itself, is not well-equipped to choose technologies for commercial exploitation or to foster the creation of new commercial technologies. Government decisions about commercial space activities must be based on information from industries about domestic and international markets. These decisions must therefore involve, in addition to NASA, agencies versed in domestic commerce and regulation, international trade, and foreign affairs.

The National Commission on Space, authorized in Public Law 98-361,* could help develop a national consensus on the long-term goals and objectives of the U.S. space program, with input from all interested Government agencies as well as from the private sector.

*Passed by Congress on June 28, 1984, and signed by the President on July 16, 1984.

Acid Rain and Transported Air Pollutants: Implications for Public Policy

THE PROBLEM

Acid rain, ozone, and fine particles such as airborne sulfate are endangering U.S. resources. These air pollutants have harmed lakes and streams, lowered crop yields, damaged man-made materials, decreased visibility, and may be threatening forests and even human health.

However, finding an equitable solution is a major policy challenge. Controlling these pollutants will involve substantial costs—higher electricity rates, and in some cases, fewer jobs for miners of high-sulfur coal and financial strain to utilities and industries.

Until recently air pollution was considered to be a local problem. Evidence now indicates that winds carry air pollutants hundreds of miles, often crossing State and national boundaries. For example, sulfur pollutants that are deposited over most of the Eastern United States, have typically traveled about 200 to 600 miles. These "transported" air pollutants are not directly covered by the Clean Air Act, the main Federal air quality law.

OTA has synthesized what is known about pollutant emissions, movements, and effects, and presents estimates of potential damage to resources if pollutant emissions are not curtailed. In addition, OTA focuses on the public policy implications of the acid rain problem—the geographic distribution of risks and costs, as well as the potential effectiveness of various control options.

Acid deposition, commonly called "acid rain," occurs when sulfur dioxide and nitrogen oxides—released primarily from burning of fossil fuels—return to the earth as rain, snow, fog, dew, and as dry particles and gases.

Acid deposition is high in most of the States east of the Mississippi as far south as Tennessee and North Carolina. Enough acid pollution is deposited throughout this area to harm aquatic life in lakes and streams located in geologically sensitive watersheds. OTA estimates there are about 3,000 lakes and 20,000 miles of streams, scattered throughout the Eastern United States, that are extremely vulnerable to acid deposition or already are acidic.

Also, sulfur pollutants accelerate the deterioration of many economically important materials, including iron and steel, zinc, paint, and stone. Sulfate particles in the air are the single greatest factor in re-

ducing visibility in the Eastern United States, responsible for about half of the decrease in visibility annually and even more during the summer.

Though research on the effects of current levels of airborne sulfates and other fine particles on human health is not yet conclusive, there is a reasonable risk that these pollutants may increase mortality rates by a few percent. Some researchers believe there is a negligible effect while others find a significant association, primarily among people with cardiac and respiratory problems.

Ozone is produced when nitrogen oxides interact with hydrocarbons. High ozone concentrations extend from the mid-Great Plains States to the East Coast, overlapping much of the region exposed to high levels of acid deposition. Ozone is causing about a 6 to 7 percent loss of U.S. agricultural productivity, overall. Reducing ozone to natural background levels would increase yields of corn and wheat by a few percent, soybean yields over ten percent and peanut yields by one-fourth.

Over the past 20 to 30 years, productivity of several species of trees has decreased in parts of the Eastern United States and Europe where high levels of air pollution prevail. Acid deposition, ozone, or a combination of both, as well as other stresses, such as climate fluctuations and disease, are being investigated as possible contributors to this problem.

During 1980, about 27 million tons of sulfur dioxide and 21 million tons of nitrogen oxides were emitted in the United States. Approximately 80 percent of the sulfur dioxide and 65 percent of the nitrogen oxides came from the 31 States bordering on or east of the Mississippi River. If energy use patterns and current laws do not change, both sulfur and nitrogen pollutants will remain high for at least the next half century—long enough to be significant to natural ecosystems.

Most of the control programs proposed in recent sessions of Congress have aimed at reducing sulfur dioxide emissions by 8 million to 10 million tons per year below 1980 levels. This level of reduction is likely to protect many sensitive aquatic resources in most areas. Risk of damage to forests, agriculture, materials and health would be reduced, and visibility will improve. However, in areas receiving the highest levels of deposition, some damage may still occur.

Such programs, however, are not without cost. Electric utilities account for about three-fourths of the sulfur dioxide emitted in the Eastern United States. Therefore, electricity consumers would ultimately pay a large share of the costs of an emissions control program. Electricity rates would increase an average of 2 to 5 percent—rising as high as 10 to 15 percent in a few Midwestern States under the more stringent proposals. If restrictions are not placed on control methods, about 20,000 to 30,000 jobs could shift from Eastern high-sulfur coal producing regions to Eastern and Western regions that mine low-sulfur coal.

CONGRESSIONAL OPTIONS

Transported pollutants pose a special problem for policymakers: balancing the concerns of those who bear the risk of damage with those who will pay the costs of control. Scientific uncertainty about many aspects of the problem complicates the decision of whether or when to control. Unfortunately, additional scientific research will not provide an unambiguous answer in the near future, nor will it ever resolve value conflicts.

Four approaches for congressional action on acid deposition and other transported air pollutants are discussed in the report:

- Mandating emissions reductions to further control the sources of transported pollutants.
- Liming lakes and streams to mitigate some of the effects of acid deposition.
- Modifying the current Federal research program so it provides more timely guidance for congressional decisions.
- Modifying existing sections of the Clean Air Act to enable the Environmental Protection Agency, States, and countries to more effectively address transported air pollutants.

Legislation to address the problem of transported air pollutants could include options from any combination of the four approaches.

If Congress chooses to further control pollutant emissions, a number of interrelated choices must be made, including which pollutant emissions to reduce, from what sources and regions, by how much, and over what time period. Congress must also choose methods to implement the reductions, allocate the costs, and address any undesired secondary consequences of the emissions controls.

Sulfur dioxide would logically be included in any control program, since sulfur compounds contribute twice as much as nitrogen compounds to acidic rainfall in the Eastern United States and are more strongly implicated with adverse effects. Because most of the air pollutants are emitted and deposited within a 20- to 30-State area of the Eastern United States—with sensitive resources distributed throughout—any control program must at least encompass this area. For a nationwide control program, both sulfur dioxide and nitrogen oxides should be considered.

A modest sulfur dioxide control program—eliminating 2 million to 5 million tons per year—could be achieved for about $1 billion per year. This would offset expected emissions increases from utility and industrial growth, and might decrease emissions by a few million tons by 2000.

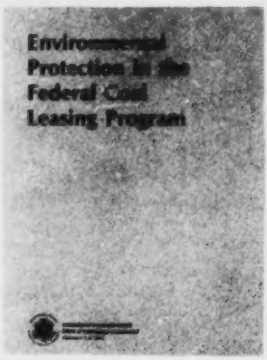
A large-scale program, reducing emissions to 8 million to 10 million tons below 1980 levels, would cost about $3 billion to $6 billion a year.

Such emissions reductions would protect many sensitive resources, though some risk of damage would still be present. If larger reductions in emissions are desired, costs will increase markedly.

While the "polluter pays" philosophy is the traditional approach to environmental regulation, some have suggested that the costs of control be spread to a larger group through such mechanisms as a tax on electricity or emissions. This would lighten the financial burden to the heavily industrialized Midwest. To minimize shifts in coal-mining jobs, controls that allow continued use of high-sulfur coal could be subsidized or mandated. Direct control costs, however, could increase by as much as 25 to 50 percent.

Environmental Protection in the Federal Coal Leasing Program

The basic framework of the Federal coal leasing program—the legislative mandates and the concept of a tiered structure of land use planning, activity planning, and mine permitting—is still workable and capable of ensuring environmental protection. However, recent policy shifts which accelerated the rate at which tracts were made available for lease, and other changes in the program's regulations—while not producing any evidence of "fatal flaws" that would totally preclude mine development on recently leased tracts—have increased the risk of adverse environmental impacts if some of those tracts are developed.



An environmentally (and economically) sound leasing program is an important part of the Nation's energy future and of public land management policy. Unless reasonable public expectations about "soundness" are satisfied, however, the likelihood of an effective and predictable Federal coal leasing program will be reduced. In particular, the planning processes during which tracts are continuously evaluated for their acceptability for leasing have become too unpredictable and unsystematic to assure compliance with the environmental mandate.

Further, the high leasing rates of the past 3 years have taxed the resources of the Bureau of Land Management (BLM)—already strained by field personnel rotations that have resulted in a loss of "institutional memory"—beyond the point where they could adequately assess the suitability of the tracts proposed to be offered. As a result, data and analyses have been inadequate for making fully informed decisions about the environmental compatibility of the tracts.

Recent actions by the Department of the Interior to review the leasing program are a positive step forward. However, OTA has identified a number of measures that could help ensure environmental protection and compliance with the existing statutory mandates, maintain a predictable and stable leasing process, and restore public confidence in the leasing program. These measures are:

1. Reduce and stabilize leasing rates to make the land area to be evaluated in a given period of time more manageable, and allow all participants in leasing, including the industry and affected communities, to plan more effectively.
2. Decentralize decisionmaking authority on tracts and tonnages to be offered and their scheduling to the Regional Coal Team or BLM State Office level, and reorganize leasing regions to match State boundaries.
3. Improve the effectiveness of public participation in planning and development activities, accommodating the concerns of special groups such as Indian tribes, States and communities, and farmers and ranchers.
4. Complete adequate Resource Management Plans by BLM (and the Forest Service), coordinating more closely with other Federal agencies, and with State and local plans to ensure that coal leasing does not undermine the goals of other programs.
5. Improve data and analyses that support planning and leasing decisions.
6. Incorporate guidelines and standards for the adequacy of pre-sale data and analyses into the program regulations for all stages in the leasing process.
7. Develop a workable threshold concept for estimating cumulative impacts and include it in the regulatory requirements for evaluating tract acceptability during land use planning and tract ranking, as well as in the environmental impact statement.
8. Establish policies and procedures for effectively using lease exchanges to protect environmentally sensitive tracts.
9. Evaluate policies and procedures for leasing split estate coal lands (where the Federal Government does not own or manage the surface).
10. Evaluate procedures for environmental assessment of Preference Right Lease Applications to determine if they provide adequate environmental protection and are consistent across regions.

Computerized Manufacturing Automation: Employment, Education, and the Workplace

Increased use of computer-based automation in manufacturing will aggravate regional unemployment. It can improve manufacturing productivity, product quality, and working conditions. It might have an enormous long-term impact on the number and kinds of jobs available, but it will not generate massive nationwide unemployment over the next decade.

In the near term, automation's employment effects will be concentrated principally in the East-Northcentral and Mid-Atlantic regions and among certain occupations, such as, metalworking machine operators.

Use of automation will gradually alter the mix of occupations and skills needed by manufacturers, and may consequently limit the mobility of manufacturing employees. In addition, automation equipment producers employ proportionately fewer production workers than do traditional metal-working industries. Many production workers may not have the skills to move from jobs where automation is used to jobs where it is produced. Thus, there is an immediate need for retraining and job counseling geared to affected persons and regions.

In the long run, overall demand will rise for engineers, technicians, maintenance personnel, senior managers, and technical sales and support staff. Demand will fall for machine operators, laborers, lower and middle managers, and clerical personnel.

Use of automation is likely to improve physical working conditions, but its effect on psychological aspects of work will depend on how the technologies are implemented. For example, automation has had negative effects such as decreasing employees' degree of autonomy and creative input. On the other hand, automation could also improve jobs by increasing the variety of tasks and challenges. U.S. exploration of automation's effects on working conditions has barely started.

The new types of automation that include the use of computer and communications technologies are becoming increasingly common, but most manufacturers have only begun to explore their potential. The reasons for this include lack of standard techniques for programing and linking computerized devices, high costs of capital, lack of know-how, and, in particular, organizational resistance to change.

New approaches to education, training, and career guidance will be needed to accommodate long-term changes in skill requirements. Suc-

cessful programs have involved close cooperation between educators, industry, labor, and government.

A strong foundation of basic reading, science, and mathematics skills appears increasingly important for all occupations, but estimated levels of functional illiteracy suggest that many prospective employees will not have that foundation.

The lack of appropriate curricula, shortages of equipment and technical faculty, and other factors suggest that on the whole, the U.S. instructional system may not now be geared to accommodate potential demands for skills relevant to an age of programmable automation. In addition, few companies or institutions help workers develop the multiple skills often needed for successful use of programmable automation.

There is a wide range of policy options for Congress to consider. Congress could choose to continue current Federal roles. Alternatively, further actions could be taken to: strengthen computerized automation research and development (especially in areas of generic research, human factors, and standards); raise employment levels and facilitate mobility among occupations and jobs; assure that automation enhances working conditions or guards against downgrading of working conditions; and make the instructional system more resilient and responsive to demands arising from the spread of automation and the changing occupational mix. The overall success of automation-related policy will depend on the health of the economy and the broader context of macroeconomic policy.

Whatever the level of Federal involvement, the most effective strategy would balance actions regarding technology development, working conditions, and employment and training. The uses and impacts of automation are only beginning. It is essential that planning for the future start now.

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Wetlands: Their Use and Regulation

Although the overall rate at which the Nation's wetlands are being converted to other uses is not alarming, the continued incremental conversion of wetlands, especially in certain inland regions of the country, may have significant adverse ecological effects over the next few decades.

Over the next several years, the Federal Government could improve ongoing efforts to manage the country's remaining wetlands and avert many of these adverse effects. First, the Federal Government could continue or accelerate its ongoing mapping of wetlands, emphasizing those areas under the greatest development pressure. Next, after mapping has been completed in a given region, wetlands could be categorized according to their relative values by policymakers in cooperation with regional groups. Third, existing wetland policies and programs could be tailored or adjusted based on the values of different wetlands. For example, higher value wetlands covered by the 404 program could be more stringently regulated and lower value wetlands less so. And finally, Congress could broaden the scope of different wetland programs (e.g., regulation, acquisition, leasing, etc.) to include the full range of wetland values, rather than continuing to focus on single values, such as wildlife habitat.

In the near-term, Congress may also wish to provide additional protection for higher value wetlands that may be subject to agricultural conversion. This could be done through acquisition or easements from the Interior Department's Fish and Wildlife Service, or through leases from the Agriculture Department's Water Bank Program. Acquisition, easements, and leases can provide comparable levels of protection; but, for a given level of funding, many more wetlands can be protected with leases than with easements or acquisition. However, leases only provide temporary protection.

To improve its future policymaking capability, more federally supported research is needed for further assessment of the ecological significance of additional wetland conversions. And Federal support could be continued for ongoing efforts to determine recent wetland trends and the effect of major policies and programs on wetlands use. Finally, a coordinating mechanism, such as an interagency working group, would help to ensure that all required activities are accomplished in a timely manner.

Existing Federal policies often affect wetlands in opposing ways. Some policies encourage conversions. For example, tax deductions and

credits can significantly reduce wetland conversion costs for farmers. Others, such as regulatory and acquisition programs, discourage conversions. The U.S. Army Corps of Engineers' regulatory program, established by section 404 of the Clean Water Act, provides the major avenue of Federal involvement in controlling the use of wetlands by regulating discharges of dredged or fill material into wetlands.

For those activities that come under regulation by the Corps, annual conversions are reduced nationwide by about 50 percent, or about 50,000 acres of wetlands per year, primarily through project modifications. Because most activities that occur in coastal wetlands are regulated by the Corps and/or State wetland programs, coastal wetlands are reasonably well-protected. However, many activities, such as excavation, clearing, and drainge for farming, are not regulated by either the Corps or most State wetland programs. These activities were responsible for the vast majority of past conversions, especially in inland areas, where 95 percent of the Nation's wetlands are located. Therefore, inland, freshwater wetlands are generally poorly protected.

Over the past 200 years, 30 to 50 percent of the wetlands in the lower 48 States have been converted to other uses. Between the mid-1950's and mid-1970's, wetland conversions occurred at a net rate of about 550,000 acres per year. This is equivalent to an annual loss of about one-half of 1 percent of the remaining wetlands. About 80 percent of these losses were due to agricultural conversions. Current rates of agricultural drainage suggest that national conversion rates have declined to about 300,000 acres per year.

Vegetated wetlands—marshes, bogs, swamps, and tundra—comprise about 5 percent, or 90 million acres, of the lower 48 States, and nearly 60 percent, or more than 200 million acres, of Alaska. In addition to their recreational benefits and esthetic qualities, these natural areas can provide valuable ecological services such as fish and wildliife habitat, water quality improvement, erosion control, flood control, and food chain support. On the other hand, some wetlands can be converted to other uses by development activities, including agriculture, port expansion, mining, oil/gas recovery, urbanization, and water resource projects.

Technologies to Sustain Tropical Forest Resources

Each year, an area of tropical forests the size of Pennsylvania is cleared while only one-tenth that much is replanted. The loss of these tropical forest resources affects people both in the Tropics and in other nations.

Tropical forests maintain the productivity of land that cannot support conventional agriculture. Forests provide fuel, food, fodder, medicines, and building materials to the people of the tropical nations. Forests also help maintain soil quality, limit erosion, stabilize hillsides, modulate seasonal flooding, and protect waterways and marine resources.

Where tropical forests are cleared, the soil is usually exposed to extreme erosion, high temperatures, and severe weed infestations. Agricultural productivity often declines, then the land is abandoned. Most of this abandoned land will not recover its former productivity.

Further, tropical forests contain the world's greatest diversity of plant and animal life. This diversity is a natural resource important to agriculture, commerce, and industry in all nations. It will become even more valuable as oil and other nonrenewable resources become more scarce and as modern biotechnology develops new uses for plants and animals.

As the population of tropical nations doubles to 4 billion over the next 30 years, the need for forest products and services will increase dramatically. To meet these needs, ways to use forests without degrading them must be developed and demonstrated.

OTA identifies existing and emerging technologies with the potential to sustain tropical forests' productivity. These include farming systems that combine trees with crops or livestock, improved charcoal production, better wood stoves, genetic improvement of trees, new approaches to park design and management, and a variety of forest management systems.

Changing technologies alone, however, will not be enough to sustain the tropical forests because the underlying causes of deforestation are institutional, social, and economic. Although many of the needed reforms can only come from the governments and people of the tropical nations, the United States has a role, especially in the areas of research, technology development, education, and resource planning.

OTA looks specifically at forests in the U.S. Caribbean and western Pacific island territories. These forests have benefited very little from

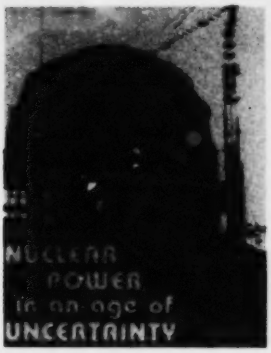
the increased international awareness of the importance of forest resources. They receive little, if any, management.

OTA identifies possible congressional actions to help conserve tropical forest resources including:

- Continue oversight hearings of the Agency for International Development and multilateral organizations to assure that U.S. development assistance supports sustainable use of forest resources as mandated by the Foreign Assistance Act.
- Strengthen the U.S. Forest Service institutes and programs in Hawaii and Puerto Rico, and through them support natural resource agencies in Puerto Rico, the U.S. Virgin Islands, and the western Pacific territories.
- Maintain low-cost availability of Landsat data and continue to support training of tropical nations' personnel in remote-sensing analysis and development planning.
- Establish U.S. tropical forestry "centers of excellence" to conduct forestry research and education.
- Promote international ad hoc committees formed to assist tropical nations in planning long-term forest development.
- Encourage tropical forestry research that is broadly interdisciplinary and relevant to both conservation and development.
- Encourage the U.S. private sector to develop and implement technologies that will sustain tropical forest resources.

Nuclear Power in an Age of Uncertainty

Without significant changes in the technology, management, and level of public acceptance, nuclear power in the United States is unlikely to be expanded in this century beyond the reactors already under construction. Currently, nuclear powerplants present too many financial risks as a result of uncertainties in electric demand growth, very high capital costs, operating problems, increasing regulatory requirements, and growing public opposition.



Despite these problems, some utilities have clearly demonstrated that the difficulties with this technology are not insurmountable. Furthermore, there are national policy reasons why it could be important to have an improved nuclear option in the future.

The present generation of reactors suffered from an immature technology and an underestimation by some utilities and their contractors of the difficulty of managing it. These problems need not recur if new reactors are ordered because new designs will incorporate many changes made to correct problems of existing reactors. In addition, only utilities with a demonstrated ability to manage nuclear construction and operation are likely to order them.

These changes are essential, but by themselves are probably not adequate to break the present impasse. Construction problems, operating mishaps, and accidents have been too serious for the confidence of the public, investors, rate and safety regulators, and the utilities themselves to be restored easily. Unless this trust is restored, nuclear power will not be a credible energy option for this country.

It appears possible, however, that a combination of additional improvements in technology and the way nuclear power is managed and regulated could restore the required confidence. Technological improvements can be very important in that effort. One approach would be to focus research and development on improving current light water reactor (LWR) designs by resolving safety issues and designing standardized reactors optimized for safety and economics.

It is possible that even greatly improved LWRs will not be viewed by the public as acceptably safe. Therefore, research and development on alternative reactors could be essential in restoring the nuclear option. Several concepts appear promising, including the high temperature gas-cooled reactor, the PIUS reactor (a concept where an LWR-type core and other critical reactor elements are submerged in a large

pool of water), and heavy water reactors. All have passive, inherent safety characteristics rather than relying on active, engineered systems to protect against accidents. Special attention should be paid to smaller reactors which have potential for factory fabrication, lower financial risk, and greater safety.

Safe and reliable operation of nuclear powerplants is an exacting task, which demands a major commitment to excellence by the utility. If a utility is unable to develop this commitment itself, the Nuclear Regulatory Commission and the Institute for Nuclear Power Operations must generate it. In extreme cases, a utility's operating license could be suspended until its nuclear operations reflect the required competence, perhaps by employing other utilities or service companies. Similarly, certification of utilities could be considered as a prerequisite for permits for new plants. These drastic steps may be warranted because public acceptance depends in part on *all* reactors performing well.

Several utilities recently have shown that it is possible to meet construction budgets and schedules even under current regulatory procedures. The regulatory process, however, is more unpredictable than necessary, and there is no assurance that safety and efficiency are being optimized. Encouraging preapproved standardized designs and developing procedures and analytical tools for evaluating proposed safety backfits would help make licensing more efficient without sacrificing safety. Legislation may not be required to effect these changes.

The improvements in technology and operations described above should produce gains in public acceptance. Additional steps may be required, however, because at present over 50 percent of the public opposes the construction of more reactors. Openly addressing the concerns of the critics and providing assurance of a controlled rate of nuclear expansion might eliminate much of the reason for public disaffection and begin to rebuild a sense of trust.

If progress can be made in all these areas, nuclear power will be much more likely to be considered when new electric generation capacity is needed. Such progress will be difficult because many divergent groups will have to work together, and substantial technical and institutional change may be necessary.

Commercial Biotechnology: An International Analysis

The United States currently leads the world in the commercialization of biotechnology, but this country's preeminence may not continue.

A well-developed life science base, the availability of financing for high-risk ventures, and an entrepreneurial spirit have established the United States as a leader in the commercialization of biotechnology. But if Federal funding for basic life science continues to decline, the science base, which supports innovation in biotechnology as well as in other fields, may be eroded.

Also, Federal funding of generic applied research and personnel training in the areas of bioprocess engineering and applied microbiology may be insufficient to support rapid commercialization. In fiscal year 1983, the United States spent significantly more on basic biotechnology research than on generic applied research in bioprocess engineering and applied microbiology.

The continued availability of financing for new biotechnology firms until they are self-supporting may be another problem. Finally, to maintain a strong competitive position, certain aspects of U.S. health, safety, and environmental regulation and intellectual property law may need to be clarified and modified.

Biotechnology, as defined in this report, is the industrial use of recombinant DNA, cell fusion, and novel bioprocessing techniques. Following the first successful directed insertion of foreign DNA into a host micro-organism in 1973, scientists in the United States and other countries recognized the potential for directing living cells to develop new and improved products and processes.

Over 100 new firms have been started in the United States in the last several years to commercialize innovations in biotechnology. Additionally, in the United States and abroad, established companies from a broad range of industries are investing in biotechnology. Potential industrial uses of these new techniques include production of new and improved pharmaceutical and animal health products, improvement of commercially important plants, production of chemicals, pollution control, and degradation of toxic wastes.

Japan is likely to be the leading competitor of the United States, followed by the Federal Republic of Germany, the United Kingdom, Switzerland, and France. A broad range of Japanese companies have extensive experience in traditional bioprocess technology, and Japan

has more bioprocessing plants and bioprocess engineers than the United States. Furthermore, the Japanese Government has targeted biotechnology as a key technology of the future and is financing cooperative interindustry biotechnology projects.

The European countries are not commercializing biotechnology as rapidly as either the United States or Japan. However, several large pharmaceutical and chemical companies in the United Kingdom, the Federal Republic of Germany, Switzerland, and France will be competitors in selected product areas.

OTA analyzes the level of activity in the competitor countries in the commercialization of biotechnology from three perspectives:

- the number and kinds of companies;
- the markets targeted by industrial R&D; and
- the interrelationships among companies and the overall organization of the commercial effort.

OTA also evaluates the following 10 factors potentially important to the commercialization of biotechnology in the competitor countries. These factors are listed roughly in order of their current importance:

- financing and tax incentives for firms;
- government funding of basic and applied research;
- personnel availability and training;
- health, safety, and environmental regulation;
- intellectual property law;
- university/industry relationships;
- antitrust law;
- international technology transfer, investment, and trade;
- government targeting policies in biotechnology; and
- public perception.

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U.S. Passenger Rail Technologies

Foreign experience and current U.S. market factors indicate that any U.S. corridor with totally new high-speed (125 mph and above) rail systems would have difficulty generating enough revenue to cover operating and capital costs. Thus, introduction of high-speed rail service in the United States will probably depend on whether the public benefits are judged sufficient to justify likely public assistance. The technologies for high-speed rail are well understood and, in themselves, present no serious obstacles.

OTA examined the experience of foreign countries to assess the outlook for high-speed passenger rail in the United States, but no specific proposals for rail corridors in the United States were evaluated. All foreign high-speed lines have been built with government assistance. The systems generally report favorable financial results with regard to operating costs, though independent audits to confirm this are not available.

Analysis of the factors that influence a passenger's choice of travel mode suggests that a potential high-speed passenger rail corridor should have some or all of the following characteristics:

- cities along a route generating major passenger travel flows in the 100- to 300-mile-trip range;
- cities with high population and high population densities;
- cities with well-developed local transit systems to feed the high-speed line; and
- a strong reason to travel between cities, generally because one city is a dominant center of commercial, cultural, or governmental activity.

High-speed systems require high ridership to meet operating costs. European and Japanese systems are located in corridors with higher population densities than any corridors being considered in the United States—except for the Washington, New York, and Boston Corridor (Northeast Corridor). Both Japan and France had reached capacity on sections of their conventional lines before implementing high-speed service.

The lowest cost option for a high-speed rail system, typically used for lower volume operations, is conventional diesel-powered equipment on existing track—the system operating in Britain. The most expensive option is to build new track and new equipment, as the Japanese have done. This cost, although always higher than that for upgrading track,

varies widely depending on terrain, land use, and population density. For example, although the new French high-speed line cost $4 million per mile, the most recently completed links of the Japanese system cost about $35 million to $40 million per mile. The earliest Japanese routes cost about $20 million per mile (in 1979 dollars).

OTA also looked into the prospects of magnetic levitation (maglev) technologies—ultra-high-speed ground transportation that relies on magnetic suspension instead of conventional steel wheels on the rail—and the status of railcar manufacturing industries.

Different types of maglev systems for intercity passenger service are being developed independently by the Federal Republic of Germany and by Japan. Although neither system appears to have insurmountable technical obstacles, both require further development and testing to substantiate technical feasibility and to determine capital and operating costs under conditions that fairly reflect those of actual revenue service. Not until 1985 will sufficient information be available from the West German tests to determine how the system will meet cost and performance standards. Japan is seeking to build a new test track and testing advanced technologies, including the superconducting magnets used in their system.

All U.S.-owned passenger railcar manufacturers have abandoned the field, and foreign owners are filling U.S. sales. U.S. manufacturers (other than the German-owned Budd Co.) are not likely to reenter the field unless the United States follows the example of Europe and Japan, which sustain their passenger railcar manufacturing industries by ensuring a stable, predictable, and planned market for rail equipment.

The U.S. market for railcars is small and uncertain. Most railcar orders for the rest of the 1980's already have been placed, and the market for the 1990's and beyond is not likely to be large enough to support more than a few small U.S. manufacturers.

International Competitiveness in Electronics

Electronics remains a leader among American industries, but U.S. manufacturers face a future in which foreign competitors may be their technological equals. Without positive action by the Federal Government, the Nation's technical superiority will continue to erode, contributing to the decline of U.S. international competitiveness in this and other industries.

Today, high-technology U.S. manufacturers of thumbnail-size integrated circuits as well as computers and communication systems remain second to none in both technology and most measures of commercial success. On the other hand, U.S. competitiveness in consumer electronics has declined precipitously. Technical and structural change in electronics will continue to be rapid, creating risks as well as opportunities for both American and foreign firms.

By any criterion, electronics is vital to the future of the U.S. economy and for national security. Even so, the Federal Government has done little to help electronics manufacturers. The contrast with industrial policies in countries like Japan is striking.

International competitiveness is closely linked to policies with domestic objectives, that is to industrial policy—which OTA uses as a neutral term to denote the collection of regulations, laws, and other policy instruments that affect business and industry. In this sense, the United States has had an industrial policy since its founding. The lesson of electronics, along with sectors like steel and automobiles that OTA has examined previously, is straightforward: future U.S. competitiveness will depend on a more coherent and consistent approach to matters of industrial policy.

In developing a more coherent industrial policy, Congress could choose from among five alternatives. While they overlap, each represents a distinct thrust. The five alternatives are:

1. a strategy that would aim broadly at preserving domestic markets and domestic jobs;
2. protection and/or support for a limited number of industries that the Government judges critical for the U.S. economy or for national security;
3. support for the technological base and infrastructure that underlie American industries;
4. promotion of the global competitiveness of U.S. firms and industries; and

5. deferral in all possible instances to the private sector when decisions concerning industrial development are to be made.

Plainly, a more coherent industrial policy offers no quick fixes for the dilemmas of the U.S. consumer electronics industry, nor any guarantees for the future competitiveness of our microelectronics or computer sectors. Just as plainly, industrial policy is a continuing activity of governments everywhere. In the United States, we can continue to leave industrial policy to the random play of events, or begin to improve the system.

The first requisite for more effective policymaking is greater agreement on the role of high-technology sectors like electronics as a driving force for future economic growth. This, in turn, depends on a greater degree of consensus on where the U.S. economy is heading and where it should head. The second requisite is better understanding of how particular Federal laws, regulations, and administrative procedures affect the competitiveness of American industry. This will require a better capability within the Federal Government for analyzing the sources of competitive strength.

If a more coherent industrial policy is far from a panacea, it nonetheless offers the best prospects for enhancing U.S. competitiveness—in electronics and in other industries, old and new. Making our industrial policies work better—evaluating, linking, and coordinating the many Government measures that make up U.S. industrial policy—could pay vast dividends throughout our economy.

An Assessment of Maritime Trade and Technology

The value of world trade to the U.S. economy has increased dramatically in the past two decades, nearly doubling during the 1970's. Although the U.S. ratio of exports to gross national product is still below that of most other industrial countries, it rose from 4.4 percent in 1970 to 8.5 percent in 1980, and could reach 15 percent by 1990.

A variety of rapid changes over the past few decades have transformed the maritime industries that are essential to world trade. But U.S. maritime policies have not kept pace with changes in world trade or the maritime industry. They remain aimed at conditions that prevailed in decades past. The U.S. maritime policy framework that exists today is outdated and appears inadequate to address critical maritime problems of national concern.

Major new or revised Federal policies are needed if the U.S. maritime industries are to remain healthy in the decades to come. Without policy changes, most segments of the U.S. maritime industry will continue to decline in size and influence.

In the past 25 years, the U.S.-flag merchant fleet has changed from the largest and most diverse in the world to a specialized fleet of modest size that is prominent only in the scheduled container-carrying segment of U.S. international trade. Practically all of U.S. petroleum imports and sizable proportions of our exports of coal, grain, and other key commodities are carried by huge foreign-flag fleets owned by U.S. maritime business interests. U.S. shipyards have maintained leadership in complex warship construction but now rarely build large merchant ships. These changes have been accompanied by international political and technological changes that have a significant impact on the economics of shipping and shipbuilding. In recent years, there has been more governmental control of trade and access to cargo than at any time in the past several decades. The changing nature of international marine transportation itself is evidenced by the concentration of businesses in fewer, larger firms; by rapid worldwide transfer of technologies; and by many ship-operating firms offering intermodal rates and services.

Because of these changes, a comprehensive and coordinated approach toward new maritime policies is necessary to clarify the national interest, define national objectives, bring effectiveness to Federal programs, and ensure consistency within industry promotion efforts.

There is no generally accepted U.S. cargo policy because national interests are not defined and strategies for international negotiation have not been developed. Federal policies and practices could have a profound influence on whether U.S.-flag ship operators are treated fairly by other countries and given equal and competitive rights to carry cargo. Lacking policies and strategies, the United States has remained on the sidelines while the rest of the world defines the rules of cargo access.

There is widespread agreement that U.S. maritime subsidy programs of the past have been counterproductive to the goal of stimulating a competitive commercial U.S. maritime industry. The present administration eliminated funding for ship construction subsidies and has sought to phase out ship-operating subsidies.

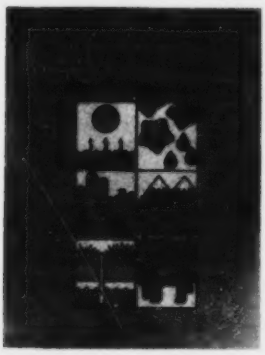
However, new policies are needed to substitute for these programs because, without Federal intervention, U.S. maritime industries cannot meet international competition, which benefits from many forms of government support. Before new programs can receive broad support in the United States, the level of Federal promotion needs to be clearly justified by specific national benefits such as the requirement to maintain an adequate defense mobilization base. Such requirements have not been defined.

It has been and remains difficult to develop a comprehensive policy that integrates the important aspects of trade promotion, cargo access, maritime, regulation, industry incentives, and maritime research. Federal agencies, lacking a coordinated approach, have often sought conflicting goals. Congress could seek to resolve some of the major conflicts through comprehensive legislation or through combined consideration of a range of legislative proposals. At a minimum, there should be Federal coordination of trade and shipping policies which are often considered separately, both within the U.S. Government and international organizations where the United States has a major role. Those policies can have a direct impact on future international trade and the participation of the United States and its shipping industry in that trade.

OTA has found that, although there are both healthy and troubled segments of the U.S. maritime industries, all sectors are becoming increasingly dependent on Federal policy decisions. And, with increasing competition in world trade as well as shipping services to carry that trade, intervention by all governments is more and more prevalent.

Water-Related Technologies for Sustainable Agriculture in U.S. Arid/Semiarid Lands

Agriculture in the arid/semiarid United States (generally the 17 Western States) is being increasingly threatened by water-related problems that are likely to intensify in the future. Western agriculture constitutes a large share of the total income derived from farming and ranching in the United States—in 1980 the Western contribution was $59 billion or 43 percent of the U.S. farm income—making Western agricultural problems of national significance.



An estimated one-half of the Western United States already is experiencing local and seasonal water-supply problems. Growing water demands from nonagricultural users plus increased problems of ground water depletion, salt buildup in soils, and water-quality deterioration are causing heightened concern about the sustainability of Western agriculture in its present form. In some areas, improved water management in irrigation may compensate for decreasing availability of affordable water. In other areas, irrigation agriculture may gradually decline and in some cases is likely to cease altogether due to water-related problems. Simultaneously, those agricultural systems based on natural precipitation (dryland and rangeland agriculture) are likely to increase in importance.

Existing and emerging technologies have potential for sustaining the long-term productivity of arid/semiarid agriculture. Successful application is site-specific, however, and depends on understanding the hydrologic cycle and other natural processes involved. Complex and changing legal, institutional, and economic issues also affect water use and technology adoption. Incompatible, incomplete, and unsynthesized data make it especially difficult to identify and verify water-related potentials and impacts of particular technologies.

An expanded and committed Federal role is fundamental to help sustain long-term agricultural productivity for the Western United States. Some current Federal activities are not effectively advancing this goal. The mountain snowpack has received inadequate Federal attention for its water-producing properties even though that water-source is primarily under Federal management and supplies the principal surface runoff for much of the Western United States. Federal agricultural programs have for the most part focused on production that is largely based on costly inputs including the use of commercial fertilizers and pesticides, frequent tillage, and the use of few, very specialized, annual crops. Already, some Western farmers, ranchers, and researchers are

questioning the suitability of these activities for arid/semiarid lands and are experimenting on their own with other technologies to reduce economic risk and maintain productivity.

OTA identified a number of congressional actions to promote long-term productivity of Western arid/semiarid agriculture including the following:

- Establish a National Center for Water Resources Research to unite university, private sector, and government water-related research activities and identify solutions to national water problems, particularly those of Western agriculture.
- Establish a small specialized analytical unit—e.g., an office of resource analysis—to provide Congress with long-range and quantitative evaluations of existing data on renewable natural resources.
- Tailor and adjust Federal programs to reflect the importance of the Western mountain snowpack for arid/semiarid lands water production.
- Develop and promote technologies for dryland and rangeland agriculture that regenerate degraded lands and sustain long-term productivity to provide new economic opportunities where traditional irrigation is threatened.
- Sustain the Federal commitment to water-quality programs including control of nonpoint agricultural pollution and public health research.
- Establish mechanisms to increase the involvement of Western agricultural water users in research and development of water-related technologies.
- Carry out Federal responsibilities to ensure that the interests of disadvantaged farmers and American Indians are equitably and fairly represented in public and private sector decisions affecting water availability and use.
- Assist States in developing computerized water-resources data bases to improve capacity for local and regional water planning and management for agricultural and other uses.

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TECHNICAL MEMORANDA

Scientific Validity of Polygraph Testing: A Research Review and Evaluation

The technical memorandum is limited to a critical review and evaluation of prior research. The memorandum does not consider, in detail, other polygraph issues such as utility, ethics, impact on employee morale and productivity, privacy, and constitutional rights. The technical memorandum, instead, focuses on the nature and application of polygraph tests, scientific controversy over polygraph testing, data from field and simulation studies, and factors that affect test validity.

Salyut: Soviet Steps Toward Permanent Human Presence in Space

The study examines the range of capabilities that the Soviets have already achieved in using men and women aboard the Salyut stations and the directions their program may take in the future.

The technical memorandum is part of a larger, continuing OTA assessment of Civilian Space Stations. It includes the result of a workshop held at OTA in December 1982.

Remote Sensing and the Private Sector: Issues for Discussion

The memorandum summarizes the requirements and conditions that Congress might want to impose if the Landsat system is transferred to the private sector. The memorandum also summarizes the social, economic, and political benefits of the U.S. remote sensing programs. It is part of a larger assessment of *International Cooperation and Competition in Civilian Space Activities.*

Update of Federal Activities Regarding the Use of Pneumococcal Vaccine

Decribes Federal activities that have taken place since 1979; reevaluates the 1979 cost-effectiveness analysis of vaccination against pneumococcal pneumonia, including new information on vaccine efficacy; and discusses policy implications.

Review of Postal Automation Strategy: A Technical and Decision Analysis

The memorandum contains a review of the United States Postal Service (USPS) decision to utilize single-line optical character readers (OCRs) instead of multi-line OCRs, and includes a comparative technical

and economic analysis of the two technologies in the context of the overall postal automation program.

BACKGROUND PAPERS

Encouraging High-Technology Development—Background Paper #2

Addresses the factors that influence the creation and location of high-technology firms and the roles that high-technology industries play in the growth and revitalization of the U.S. economy.

Impacts of Neuroscience

Neuroscience, research on the nervous system, is already playing a critical role in preventing and treating the diseases of older Americans. The background paper is part of a larger study on "Technology and Aging in America."

Directed Energy Missile Defense in Space

Introduces the new technologies that form the basis of President Reagan's proposal to study the possibilities of developing a defense against Soviet nuclear ballistic missiles. It focuses on the so-called "Star Wars" technologies which propose the interception of missiles in their boost phase by directed energy weapons. It also summarizes the possible roles of these technologies as part of defensive systems, as well as the Soviet countermeasures and other problems which must be overcome.

Technology, Renewable Resources, and American Crafts

Summarizes technology's effects on crafts—traditional and contemporary—that use renewable resources as raw materials. The paper is part of OTA's ongoing monitoring of renewable resource/technology issues for Congress.

CASE STUDIES

The Emergence of Nuclear Magnetic Resonance Imaging Technology: A Clinical, Industrial, and Policy Analysis

Nuclear Magnetic Resonance (NMR) is an exciting new diagnostic technology that uses radiowaves and magnetic fields, rather than X-rays, to produce images of the interior of the human body. NMR provides excellent distinctions between different structures and tissues without requiring the injection of potentially toxic contrasting agents

and it is not affected by bone. This technique offers the possibility of earlier detection and more accurate diagnosis of many ailments.

WORKSHOP PROCEEDINGS

Arms Control in Space

Summary of findings and proceedings, of six workshop sessions held by OTA in Washington, DC, on January 30 and 31, 1984, to explore and examine antisatellite (ASAT) weapons as one aspect of space arms control.

The proceedings report the viewpoints and ideas discussed during the conference and identify areas of controversy and general agreement.

Section III.—Work in Progress

More than 25 projects were in progress during fiscal year 1984, including 18 new studies.

This section lists the titles of assessments underway or in press, as of September 30, 1984. For a fuller description of these projects, please refer to the current "Assessment Activities," OTA-PC-105. This booklet may be obtained from OTA by calling OTA's Publishing Office (202) 224-8996.

Energy, Materials, and International Security Division

Technology and the American economic transition

Energy and Materials Program
- Potential U.S. natural gas availability
- Load management and generating technologies for electric utilities in the 1990s
- Technologies for surface mine reclamation on Western Federal lands

Industry, Technology, and Employment Program
- Technologies to reduce U.S. materials import vulnerability
- Technology and structural unemployment: retraining adult displaced workers
- Cleanup of uncontrolled hazardous waste sites under Superfund
- International competition: the services industries

International Security and Commerce Program
- Strategic command, control, communications, and intelligence systems
- International cooperation and competitiveness in civilian space activities
- New ballistic missile defense technologies

Health and Life Sciences Division

Food and Renewable Resources Program
- Technology, public policy, and the changing structure of American agriculture
- Technologies to maintain biological diversity
- Integrated renewable resource management for U.S. insular areas

Health Program
- Evaluation of Agent Orange protocol (mandated study)
- Preventing illness and injury in the workplace
- Federal policies and the medical devices industry
- Status of biomedical research and related technology for tropical diseases
- Blood policy and technology
- Medical technology and diagnosis-related groups: evaluating Medicare's Prospective Payment System
- Technology and Indian health care: effectiveness, access, and efficiency
- Physicians and medical technology: use, cost, and payment methods
- Technologies for determining mutation frequencies in human beings

Biological Applications Program
- Technology and aging in America
- Alternatives to animal use in testing and experimentation
- Reproductive hazards in the workplace
- Life sustaining technologies and the elderly
- Disorder causing dementia

Science, Information, and Natural Resources Division

Communication and Information Technologies Program
- Information technology R&D: critical trends and issues
- Information and communication technologies and the office
- Federal Government information technology: administrative process and civil liberties
- Intellectual property rights in an age of electronics and information

Oceans and Environment Program
- Managing commercial high-level radioactive waste
- Protecting the Nation's groundwater from contamination
- Technology for developing offshore oil and gas resources in hostile environments
- Technologies for disposing of waste in the ocean

Science, Transportation, and Innovation Program
- Civilian space stations and the U.S. future in space
- Hazardous materials transportation: technology issues

Section IV.—Organization and Operations

Created by the Technology Assessment Act of 1972 [86 Stat. 797], OTA is an agency of the legislative branch of the Federal Government (a copy of the Act is found in app. C, p. 116). OTA began operations as the second session of the 93d Congress convened in January 1974.

The Act provides for a bipartisan Congressional Board, a Director, and such other employees and consultants as may be necessary to conduct the Office's work.

The Congressional Board is made up of six Senators, appointed by the President pro tempore of the Senate, and six Representatives, appointed by the Speaker of the House, evenly divided by party. In 1984, Cong. Morris Udall (D-Arizona) and Sen. Ted Stevens (R-Alaska) served as the Chairman and Vice Chairman, respectively, of the Board. The two posts alternate between the Senate and House with each Congress. The Board members from each House select their respective officer.

The Congressional Board sets the policies of the Office and is the sole and exclusive body governing OTA. The Board appoints the Director, who is OTA's chief executive officer and a nonvoting member of the Board.

The Act also calls for a Technology Assessment Advisory Council composed of 10 public members eminent in scientific, technological, and educational fields, the Comptroller General of the United States, and the Director of the Congressional Research Service of the Library of Congress. The Advisory Council advises the Board and the Director on such matters as the balance, comprehensiveness, and quality of OTA's work, and OTA's nongovernmental resources.

In providing assistance to Congress, OTA is to: identify existing or probable impacts of technology or technological programs; where possible, ascertain cause-and-effect relationships of the applications of technology; identify alternative technological methods of implementing specific actions; identify alternative programs for achieving requisite goals; estimate and compare the impacts of alternative methods and programs; present findings of completed analyses to the appropriate legislative authorities; identify areas where additional research or data collection is required to provide support for assessments; and undertake such additional associated activities as may be necessary.

INITIATION, PROCESSING, AND FLOW OF ASSESSMENTS

OTA's primary function is to provide congressional committees with assessments or studies that identify the range of probable positive and negative consequences, social as well as physical, of policy alternatives affecting the uses of technology. Requests for OTA assessments may be initiated by:

- the chairman of any standing, special, select, or joint committee of Congress, acting alone, at the request of the ranking minority member, or at the request of a majority of the committee members;
- the OTA Board; or
- the OTA Director, in consultation with the Board.

The authorization of specific assessment projects and the allocation of funds for their performance is the responsibility of the OTA Board.

ORGANIZATIONAL STRUCTURE

The Office is organized into three operating divisions, each headed by an assistant director. The three divisions are Energy, Materials, and International Security; Health and Life Sciences; and Science, Information, and Natural Resources. They encompass assessments grouped in the areas of energy and materials; international security and commerce; industry, technology, and employment; biological applications; food and renewable resources; health; communication and information technologies; oceans and environment; and science, transportation, and innovation. See chart detailing OTA's organizational structure.

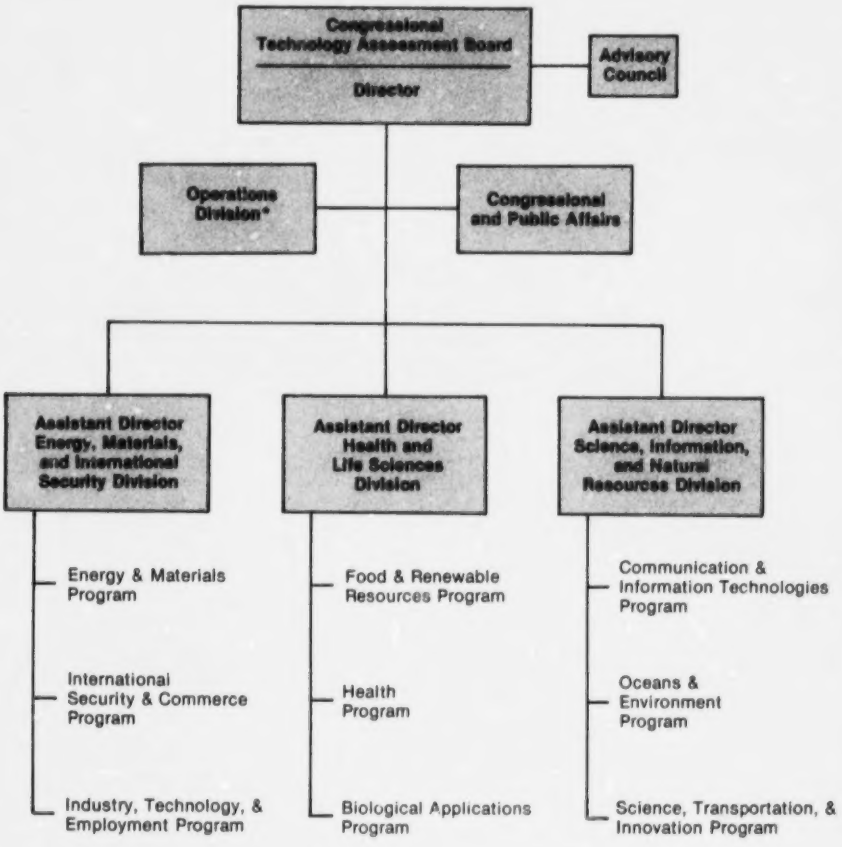
Staff professionals represent a wide range of disciplines and backgrounds, including the physical, biological, and environmental sciences, engineering, social sciences, law, and public administration. Professionals from executive branch agencies, detailed to OTA on a temporary basis, and participants in several congressional fellowship programs also contribute to the work of the Office.

Public Involvement

The private sector is heavily involved in OTA studies as a source of expertise and perspectives while an assessment is in progress. Contractors and consultants are drawn from industry, universities, private research organizations, and public interest groups.

OTA works to ensure that the views of the public are fairly reflected in its assessments. OTA involves the public in many ways—through advisory panels, workshops, surveys, and formal and informal public

OTA ORGANIZATION CHART


Congressional Technology Assessment Board
Director
Advisory Council
Operations Division*
Congressional and Public Affairs
Assistant Director Energy, Materials, and International Security Division
Assistant Director Health and Life Sciences Division
Assistant Director Science, Information, and Natural Resources Division
Energy & Materials Program
International Security & Commerce Program
Industry, Technology, & Employment Program
Food & Renewable Resources Program
Health Program
Biological Applications Program
Communication & Information Technologies Program
Oceans & Environment Program
Science, Transportation, & Innovation Program

*Operations Division consists of the following units: Administrative Services, Budget and Financial Operations, Information Center, Personnel Office, and Publishing Office.

meetings. These interactions provide citizens with access to information and help OTA to remain sensitive to the full array of perspectives, not only of the recognized stakeholders, but also of technically trained and lay persons.

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OPERATIONS

Publishing Activities

During fiscal year 1984, OTA delivered 37 published documents to Congress. These included: 17 assessment reports, 5 technical memoranda, 4 background papers, 3 health technology case studies, 1 workshop proceeding, and 7 administrative reports.

Requests for OTA Publications

During the period September 30 through October 1, 1984, OTA's Publishing Office received an average of 149 telephone and mail requests per day. Additional requests were processed by OTA program offices and the OTA Congressional Relations and Public Affairs Office and are not included in the above statistics.

Private Sector Reprinting of OTA Publications

To date, 44 OTA publications have been reprinted (in whole or in part) by commercial publishers or private organizations. Among the reports reprinted during the fiscal year were:

- Pergamon Press, Inc. (NY) reprinted the following: *Commercial Biotechnology: An International Analysis*, and *Computerized Manufacturing Automation: Employment, Education, and the Workplace*;
- Petrocelli Books, Inc. (NJ) reprinted *Computer-Based National Information Systems: Technology and Public Policy*;
- UNIPUB, Inc. (NY) reprinted *Acid Rain and Transported Air Pollutants*;
- National Technical Information Service (VA) reprinted *Health Case Study 27: Nuclear Magnetic Resonance Technology: A Clinical, Industrial, and Policy Analysis*.

Sales of Publications

Government Printing Office.—Sales of OTA publications by the Superintendent of Documents continue to increase. In fiscal year 1984 the number of titles put on sale was 163 and GPO sold 25,176 copies.

National Technical Information Service.—NTIS sells scientific reports and papers that are, generally, not in great demand but are useful for scientific researchers. NTIS is the outlet for OTA's assessment working papers and contractor reports, plus those reports that are out out print by GPO. During fiscal year 1984, NTIS sold 2,485 copies of OTA reports.

Organizational Roster of OTA Staff as of September 1984

OFFICE OF THE DIRECTOR

John H. Gibbons, *Director*
Sue Bachtel, *Executive Assistant*
Holly Gwin, *Research Analyst*
Glenda Lawing, *Secretary*

Congressional and Public Affairs Office

Mary Procter, *Director of CPA*
Jean McDonald, *Press Officer*
Ellen Mika, *Assistant to Press Officer*
Karen Piccione, *Administrative Assistant*
Eugenia Ufholz, *Congressional Relations Officer*

Medical Services

Rose McNair, *Resident Nurse*

ENERGY, MATERIALS, AND INTERNATIONAL SECURITY DIVISION

Lionel S. Johns, *Assistant Director*
Beth Alexiou, *Division Assistant*

Technology and Economic Transition

Henry Kelly, *Project Director*
Linda Long, *Administrative Assistant*

Energy and Materials Program

Richard Rowberg, *Program Manager*
Peter Blair, *Senior Analyst*
Thomas Bull, *Senior Analyst*
Alan Crane, *Senior Associate*
Steve Plotkin, *Senior Analyst*
Pidge Quigg, *Administrative Assistant*
Jenifer Robison, *Senior Analyst*
Edna Saunders, *Secretary*
Joanne Sedor, *Analyst*
Richard Thoreson, *Senior Analyst*

International Security and Commerce Program

Peter Sharfman, *Program Manager*
Douglas Adkins, *Senior Analyst*
Eric Bazques, *Analyst*
Bruce Blair, *Analyst*
Jannie Coles, *Secretary*
Richard Dalbello, *Analyst*
Gerald Epstein, *Analyst*
Martha Harris, *Senior Analyst*
Tom Karas, *Senior Analyst*
Gordon Law, *Senior Analyst*
Nancy Lubin, *Analyst*
Dorothy Richroath, *Editorial Assistant*
Jacqueline Robinson, *Administrative Assistant*
Ray Williamson, *Senior Analyst*

Industry, Technology, and Employment Program

Audrey Buyrn, *Program Manager*
John Alic, *Senior Analyst*
Andrea Amiri, *Secretary*
Lance Antrim, *Senior Analyst*
Patricia Canavan, *Administrative Assistant*
Wendell Fletcher, *Senior Analyst*
Kitty Gillman, *Senior Analyst*
Julie Gorte, *Analyst*
Joel Hirschhorn, *Senior Associate*
Karen Larsen, *Senior Analyst*
Kirsten Oldenburg, *Analyst*

HEALTH AND LIFE SCIENCES DIVISION

Roger Herdman, *Assistant Director*
Ogechee Koffler, *Division Assistant*
Kerry Kemp, *Division Editor*

Biological Applications Program

Gretchen Kolsrud, *Program Manager*
Robert Cook-Deegan, *Senior Analyst*
Gary Ellis, *Analyst*

Robert Harootyan, *Analyst*
Timothy Hart, *Senior Analyst*
Linda Rayford, *Secretary*
Sharon Smith, *Administrative Assistant*
Louise Williams, *Senior Analyst*

Food and Renewable Resources Program

Walter E. Parham, *Program Manager*
Patricia Durana, *Administrative Assistant*
Nellie Hammond, *Secretary*
Alison Hess, *Analyst*
Michael Phillips, *Senior Analyst*
Susan Shen, *Analyst*
Carolyn Swann, *Secretary*
Phyllis Windle, *Analyst*

Health Program

Clyde J. Behney, *Program Manager*
Anne Kesselman Burns, *Analyst*
Virginia Cwalina, *Administrative Assistant*
Beckie I. Erickson, *Secretary*
Hellen Gelband, *Analyst*
Cynthia King, *Analyst*
Larry Miike, *Senior Analsyt*
Brenda Miller, *Word Processor/ P.C. Specialist*
Gloria Ruby, *Analyst*
Jane Sisk, *Senior Associate*
Judith Wagner, *Senior Analyst*

Special Projects

Michael Gough, *Senior Associate*
Karl Kronebusch, *Analyst*

SCIENCE, INFORMATION, AND NATURAL RESOURCES DIVISION

John Andelin, *Assistant Director*
Doris Smith, *Division Assistant*

Communication and Information Technologies Program

Rick Weingarten, *Program Manager*
Lauren Ackerman, *Research Analyst*
Prudence Adler, *Analyst*
Marjory Blumenthal, *Analyst*
Elizabeth Emanuel, *Administrative Assistant*
Karen Gamble, *Analyst*
Linda Garcia, *Analyst*
Shirley Gayheart, *Secretary*
Jennifer Nelson, *Research Assistant*
Zalman Shavell, *Project Director*
Jean Smith, *Analyst*
Chuck Wilk, *Senior Analyst*
Fred Wood, *Senior Analyst*

Oceans and Environment Program

Robert Niblock, *Program Manager*
William Barnard, *Project Director*
Kathleen Beil, *Administrative Assistant*
Thomas Cotton, *Senior Analyst*
James Curlin, *Senior Associate*
Robert Friedman, *Senior Analyst*
Joan Harn, *Analyst*
Peter Johnson, *Senior Associate*
Daniel Kevin, *Analyst*
Jacqueline Mulder, *Secretary*
Kay Patteson, *Secretary*
Paula Stone, *Senior Analyst*

Science, Transportation, and Innovation Program

Nancy Naismith, *Program Manager*
Phil Chandler, *Senior Analyst*
Marsha Fenn, *Administrative Assistant*
Barry Holt, *Analyst*
Larry L. Jenney, *Senior Analyst*
Edith Page, *Analyst*
Paul Phelps, *Analyst*
Betty Jo Tatum, *Secretary*
Lucia Turnbull, *Analyst*

OPERATIONS DIVISION

Bart McGarry, *Operations Manager*
John Bell, *Senior Systems Integration Analyst*

Administrative Services

Thomas P. McGurn, *Administrative Officer*
Susan Carhart, *General Counsel*
Alexandra Ferguson, *Director of Contracts*
Edith Franzen, *Conference Center Coordinator*
Bryan Harrison, *Office Automation Systems Analyst*
Jackie McGee, *Contracts Assistant*
Lisa Raines, *Attorney/Analyst*

Budget and Financial Operations

Jane Easton, *Budget and Finance Officer*
Joan Camino, *Budget and Finance Assistant*
Carolyn Harris, *Budget Specialist and Clerical Assistant*
Catherine Henry, *Budget, Financial, and Systems Analyst*
Phil Jackson, *Management Information Systems Coordinator*
Ted Wagner, *Accounting and Budget Analyst*

Information Center

Martha Dexter, *Manager, Information Services*
Suzanne Boisclair, *Information Technician*
Vermille Davis, *Information Technician*
Leslie Fleming, *Information Technician*
Gail Kouril, *Assistant Manager, Information Services*

Personnel Office

William Norris, *Personnel Officer*
Lola Craw, *Personnel Specialist*
Denise DeSanctis, *Personnel Specialist*
Marsha Williams, *Administrative Assistant*

Publishing Office

Joe Henson, *Publishing Officer*
John Bergling, *Graphic Designer/Illustrator*
Kathie S. Boss, *Technical Specialist*
Debra Datcher, *Administrative Assistant*

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Appendixes

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Appendix A
Technology Assessment Advisory Council

The Technology Assessment Advisory Council (TAAC) was established by OTA's statute, and members are appointed by OTA's Congressional Technology Assessment Board (TAB). The Council advises TAB and the Director on issues and other matters related to science, technology, and technology assessment.

Members of TAAC on September 30, 1984, were:

Charles M. Kimball, *Chairman*

Dr. Kimball is President Emeritus of the Midwest Research Institute, having previously served there as Chairman of the Board and President. He is a former member of the Board of Directors of Trans World Airlines. He has served on several government scientific commissions and advisory councils and has written extensively for business, management and scientific publications.

Earl Beistline

Dr. Beistline is a private consultant in Fairbanks, Alaska. He is former Dean of the School of Mineral Industry, and also Provost of the University of Alaska.

Claire T. Dedrick

Dr. Dedrick is Executive Officer of the State Land Commission of California. She is a former member of the State of California Air Resources Board, a former California Public Utilities Commissioner, and has served as Secretary for Resources with The Resources Agency of the State of California.

James C. Fletcher

Dr. Fletcher is Whiteford Professor of Technology and Resources, University of Pittsburgh. He is former Administrator of NASA, President of the University of Utah, and Vice President for Systems at Aerojet General.

S. David Freeman

Mr. Freeman is currently a private consultant. He is former Chairman and member of the Board of the Tennessee Valley Authority. He has headed the energy policy staff of the President's Office of Science and Technology Policy; directed the Ford Foundation Energy Policy Project; and served as assistant to the Chairman of the Federal Power Commission.

Carl N. Hodges

Mr. Hodges is Director of the University of Arizona Environmental Research Laboratory and Chairman of the Arizona Solar Energy Commission. He currently serves as a member of the National Academy of Sciences' Advisory Committee on Technology Innovation and as a member of the Arizona-Mexico Commission. Mr. Hodges is a Fellow of the AAAS.

Rachel McCulloch

Dr. McCulloch is Associate Professor of Economics at the University of Wisconsin, currently on leave at the Hoover Institution at Stanford University. She has served as a consultant to the Federal Reserve Board; is a former member of the U.S. Cabinet Task Force on Oil Import Control; and presently serves as a member of the Presidential Commission on Industrial Competitiveness.

William J. Perry

Dr. Perry is a managing director in the investment banking firm of Hambrecht & Quist, Inc. Prior to joining H&Q, he was the U.S. Under Secretary of Defense for Research and Engineering. He is a member of the National Academy of Engineering. Dr. Perry will succeed Dr. Kimball as TAAC Chairman in 1985.

David S. Potter

Dr. Potter is Vice President, Power Products and Defense Operations Group at General Motors. He is formerly Assistant Secretary of the Navy for Research and Development and Under Secretary of the Navy. He is a member of the National Academy of Engineering. Dr. Potter will serve as TAAC's Vice Chairman commencing in 1985.

Lewis Thomas

Dr. Thomas is President Emeritus of the Memorial Sloan-Kettering Cancer Center and University Professor at the State University of New York at Stony Brook. He is a former member of the President's Biomedical Research Panel and of the President's Science Advisory Committee. Dr. Thomas is a distinguished lecturer and author in the medical field. He received the National Book Award in the arts and letters for his book, *Lives of a Cell*. Dr. Thomas is a member of the National Academy of Sciences and the Institute of Medicine.

Statutory Members

Charles A. Bowsher

Mr. Bowsher is Comptroller General of the United States and Director of the U.S. General Accounting Office.

Gilbert Gude

Mr. Gude is Director of the Congressional Research Service, U.S. Library of Congress.

Appendix B
List of Advisors and Panel Members*

ENERGY, MATERIALS, AND INTERNATIONAL SECURITY DIVISION

Technology and Economic Transition

Technology and the American Economic Transition Advisory Panel

David S. Saxon, *Chair*
Chairman of the Corporation
Massachusetts Institute of Technology

Claude Ballard
Partner
Goldman Sachs

William Baumol
Department of Economics
Princeton University

Harvey Brooks
Professor
John F. Kennedy School of Government
Harvard University

Richard Crowder
Senior Vice President for Strategic Planning and Corporate Risk Officer
Pillsbury Co.

Thomas G. Denomme
Vice President
Corporate Strategic Planning
Chrysler Corp.

Judy Gregory
Research Associate
Department of Professional Employees
AFL-CIO

Henry Lichstein
Vice Chairman
Citicorp/Citibank

Mary Jo Manning
Partner
Wilkes, Artis, Hedrick, & Lane

Ray Marshall
Professor
LBJ School of Public Affairs
University of Texas

John J. McNamara
President
Young & Rubicam USA

Kathleen O'Reilly
Executive Director
Citizens Utility Board

Charles F. Sabel
Professor
Department of Science, Technology, and Society
Massachusetts Institute of Technology

George M. Scalise
Senior Vice President and Administrative Officer
Advanced Micro Devices

Barbara Starfield
Center for Advanced Studies in Behavioral Science

Arthur G. Wirth
Department of Education
Washington University

Howard Young
Director, Social Security Department
United Auto Workers

Workshop: Technology and the Health Industry

Robert Fischell
Applied Physics Laboratory
Johns Hopkins University

Gordon Gayner
O'Connor & Hannan

Peter J. Goldschmidt
Director, Health Services Research and Development Service
Veterans Administration

Karen Ignagni
Assistant Director
Department of Occupational Safety, Health, and Social Security
AFL-CIO

*Affiliations are at time of appointment to panel or workshop.

David Lederman
President
Applied Biomedical Corp.

John Lind
Vice President of Development
Massachusetts Hospital Association

Don Louriea
Department of Preventive Medicine
New Jersey Medical School

Don Marlowe
Director, Division of Medical Engineering
Center for Medical Devices and Radiological Health
Food and Drug Administration

Lawrence Morris
Senior Vice President
Professional and Provider Affairs
Blue Cross and Blue Shield Association

William Munier
Consultant

Lou Nayman
Assistant Director
Federation of Nurses and Health Professionals

Morton L. Patterson
Director, Cost Benefit Studies
Smith, Kline & French Laboratories

Joseph Perpich
Vice President for Planning and Development
Maloy Laboratories
Revlon Health Care Group

Wayne Roe
Vice President
Economic Research and Policy
Health Industries Manufacturers Association

Harvey Sachs
Consultant

Edward Sandik
Chief, Operation Research Branch
National Cancer Institute
National Institutes of Health

Workshop: Technology Changes and Impacts on the Building Construction Industries

Alton S. Bradford
Assistant Commander for Engineering and Design
Naval Facilities Engineering Command
U.S. Department of the Navy

Don O. Carlson
Editor and Publisher
Automation in Housing and Manufactured Home Dealer Magazine

David E. Claridge
Associate Professor of Civil, Environmental, and Architectural Engineering
Building Energy Engineering Program
University of Colorado

Michael Clevenger
Principal Technical Consultant
Real Estate Division
Xerox Corp.

Albert Dietz
Professor Emeritus
School of Architecture and Planning
Massachusetts Institute of Technology

Eric Dluhosch
Associate Professor of Building Technology
School of Architecture and Planning
Massachusetts Institute of Technology

John P. Eberhard
Executive Director
Advisory Board on the Built Environment
National Academy of Sciences

James G. Gross
Deputy Director
Center for Building Technology
National Bureau of Standards
U.S. Department of Commerce

Harry Mileaf
Director of Technology and Product Development
Sweet's Division
McGraw-Hill Information Systems Co.

John P. Millhone
Director
Office of Buildings and Community Systems
U.S. Department of Energy

Piero N. Patri
AIA
Whisler-Patri

Richard C. Reisman
AIA, Associate
Whisler-Patri

Charles H. Thornton
President
Lev Zetlin Associates, Inc.

Richard L. Tucker
Director
Construction Industry Institute
College of Engineering
The University of Texas at Austin

W. R. Wendel
President
Space Structures International Corp.

Raymond P. Whitten
Chief, Terrestrial Applications
Technology Utilization Office
National Aeronautics and
Space Administration

Workshop: Health Policy

Leonard Fenniger
Former Vice President for
Scientific Affairs
American Medical Association

Gordon K. Gayer
General Counsel
Offices of O'Connor & Hannon

John Newman
Director of Strategic Marketing
Research
General Mills

Mary Poulin
Research Associate
Institute for the Future

Michael Riddiough
Consultant

David Rosenbloom
Vice President
Health Data Institute

Howard Salmon
Vice President
Center for Health Studies
Health Corp. of America

Kathy Schoen
Research Director
Service Employees' International Union

Gordon Trapnell
Expert Consultant
Actuarial Research Corp.

Kenneth Warner
Public Health Research
Department of Health Planning and
Administration
School of Public Health
University of Michigan

James Webber
Management Consultant

Gail Wilensky
Director of Research
Center for Health Information,
Research, and Analysis
Project HOPE

Energy and Materials Program

Nuclear Power in an Age of Uncertainty
Advisory Panel

George Rathjens, *Chair*
Director
Center for International Studies
Harvard University

James K. Asseltine
Commissioner
U.S. Nuclear Regulatory Commission

Jan Beyea
Senior Scientist
National Audubon Society

Richard Dean
Vice President
General Atomic Corp.

Thomas Dillon
Principal Deputy Assistant Secretary
for Nuclear Energy
U.S. Department of Energy

George Dilworth
Manager
Tennessee Valley Authority

Linn Draper
Vice President
Gulf States Utilities

Victor Gilinsky
Commissioner
U.S. Nuclear Regulatory Commission

Fritz Heimann
Counsel
General Electric Co.

Leonard Hyman
Vice President
Merrill Lynch, Pierce, Fenner & Smith

Robert Koger
Chairman
North Carolina Utilities Commission

Myron Kratzer
Vice President
International Energy Associates, Ltd.

Byron Lee
Senior Vice President
Commonwealth Edison

Jessica Tuchman Mathews
Vice President
World Resources Institute

Arthur Porter
Consultant

David Rose
Professor of Nuclear Physics
Massachusetts Institute of Technology

Lee Schipper
Staff Scientist
Lawrence Berkeley Labs

James Sweeney
Director
Energy Modeling Forum
Stanford University

Eric Van Loon
Executive Director
Union of Concerned Scientists

Workshop: Nuclear Reactor Research and Development

Robert Fri, *Chair*
President
Energy Transition Corp.

John Berga
Washington Representative
Electric Power Research Institute

Merwin Brown
Manager for Program Development
Gas Cooled Reactor Associates

Gordon L. Chipman, Jr.
Deputy Assistant Secretary for Breeder Reactor Programs
U.S. Department of Energy

Thomas Cochran
Staff Director
Natural Resources Defense Council

Richard Dean
Vice President, Reactor Programs
General Atomics Corp.

George Dilworth
Assistant General Manager
TVA

Arthur Fraas
Consultant

John P. Gibbons
Engineer in Charge, Research
Philadelphia Electric

Daniel Giessing
Director of Nuclear Regulation and Safety
U.S. Department of Energy

Simcha Golan
Manager, Nuclear Systems Group
Bechtel Group, Inc.

Jerry Griffith
U.S. Department of Energy

Kare Hannerz
Senior Scientist
ASEA-ATOM

Richard Hubbard
Vice President
MHB Technical Associates

Nancy Jeffery
Research Assistant
Committee on Science and Technology
U.S. House of Representatives

Paul Kasten
Director, Gas Cooled Reactor Programs
Oak Ridge National Laboratory

Richard Lester
Department of Nuclear Engineering
Massachusetts Institute of Technology

Walter Loewenstein
Deputy Director, Nuclear Power Division
Electric Power Research Institute

Gail Marcus
Assistant Chief, Science Policy Research Division
Congressional Research Service
Library of Congress

Roger Mattson
Director, Systems Integration
Nuclear Regulatory Commission

Mark Mills
President
Science Concepts

Keith Paulson
Manager, Plant Integrated Systems
Westinghouse Electric Corp.

Howard Rohm
U.S. Department of Energy

Charles L. Storrs
Director of Advanced Development
Combustion Engineering

John Wett
Manager, LMFBR Projects
Westinghouse Electric Corp.

John Young
Vice President
International Energy Associates, Ltd.

Potential U.S. Natural Gas Availability Advisory Panel

William Vogely, *Chair*
Department of Mineral Economics
Pennsylvania State University

Marc Cooper
Research Consultant
Consumer Energy Council of America

Lloyd Elkins
Petroleum Consultant

Ed Erickson
Professor of Economics and Business
North Carolina State University

Daniel Grubb
Vice President, Gas Supply
Natural Gas Pipeline Co.

John Haun
Professor of Geology
Colorado School of Mines

Donald Kash
Director
Science and Public Policy Program
University of Oklahoma

Harry C. Kent
Director
Potential Gas Agency
Colorado School of Mines

Lawrence Moss
Energy/Environmental Design and Policy Analysis

Roy E. Roadifer
Chief Geologist
Mobil Oil Corp.

Benjamin Schlesinger
Principal
Energy and Environment Division
Booz, Allen & Hamilton, Inc.

John C. Sharer
Assistant Director
Unconventional Natural Gas
Gas Research Institute

John Weyant
Deputy Director
Energy Modeling Forum
Stanford University

Ex Officio:
John Schanz
Senior Specialist in Energy Research Policy
Congressional Research Service
Library of Congress

U.S. Vulnerability to an Oil Import Curtailment: The Oil Replacement Capability Advisory Panel

Rodney W. Nichols, *Chair*
Executive Vice President
The Rockefeller University

Alvin Alm
Deputy Director
U.S. Environmental Protection Agency

Richard E. Archer
Assistant Professor
Design Program
Southern Illinois University

Jan Brinch
Energy Analysis and Planning
Mueller Associates

Nazli Choucri
Professor
Department of Political Science
Massachusetts Institute of Technology

Ernest L. Daman
Senior Vice President
Foster Wheeler Corp.

Michael Del Grande
Manager, Energy and Environment
American Telephone & Telegraph Co.

Robert Hemphill, Jr.
Associate Director
Applied Energy Services, Inc.

Brad Holloman
New York State Energy Research Development Authority

Robert L. Judd
Director
Governor's Office of Appropriate Technology
State of California

Terry Lash
Deputy Director
Department of Nuclear Safety
State of Illinois

Ray Maliszewski
Assistant Vice President
Bulk Transmission Planning
American Electric Power Service Corp.

Hal Miller, Jr.
Vice President for Planning and Rates
Transco Energy Co.

Roberta Nichols
Vice President
Ford Motor Co.

Christopher Palmer
Director, Energy and Environment
National Audubon Society

Richard A. Rettig
Professor
Department of Social Sciences
Illinois Institute of Technology

Walter S. Salant
Senior Economist (retired)
The Brookings Institution

Joanna Underwood
Executive Director
INFORM

Fred Wilson
Assistant to the Senior Vice President
Texaco, Inc.

Herb H. Woodson
Director, Center for Energy Studies
University of Texas

Load Management and Generating Technologies for Electric Utilities in the 1990s Advisory Panel

George Seidel, *Chair*
Chairman, Department of Physics
Brown University

Edward Blum
Vice President
Investment Banking Division
Merrill Lynch Capital Markets

Byron R. Brown
Consultant Manager
Engineering Service Division
Engineering Department
E. I. du Pont de Nemours & Co.

Bill D. Carnahan
General Manger
City of Fort Collins Light & Power

Mark Cooper
Research Director
Consumer Energy Council of America

Brian E. Curry
Director, Capacity Planning
Northeast Utilities

Janice G. Hamrin
Executive Director
Independent Energy Producers

William B. Harrison
Senior Vice President
Southern Co. Services, Inc.

Eric Leber
Director of Energy Research
American Public Power Association

Paul Maycock
President
Photovoltaic Energy Systems

Charles McCarthy
Vice President
Advanced Engineering
Southern California Edison

Anne F. Mead
Commissioner
New York State Public Service Commission

Alan Miller
Associate Director
World Resources Institute

Bruce W. Morrison
Vice President
Westinghouse Electric Corp.

Fred Schweppe
Electrical Engineering Department
Massachusetts Institute of Technology

Jon Veigel
President
North Carolina Alternative Energy Corp.

Workshop #1: Investment Decisions

James Stukel, *Chair*
Professor
Civil and Mechanical Engineering
University of Illinois

Edward Blum
Vice President
Investment Banking Division
Merrill Lynch Capital Markets

Jack Davey
Vice President for Planning and Forecasting
Middle South Utilities

Scott Fenn
Director, Programs on Energy and Electric Utilities
Investor Responsibility Research Center, Inc.

Jerry Huck
Manager for Planning
Illinois Power Co.

Sally Hunt
Corporate Economist
Consolidated Edison Co.

Jim Liles
Acting Chief, Regulatory Policy Branch
Federal Energy Regulatory Commission

Lynn Maxwell
Staff Chief
Power Planning Staff
Tennessee Valley Authority

Anne F. Mead
Commissioner
New York State Public Service Commission

Charles Mengers
Director
Research and Testing Division
Philadelphia Electric Co.

Thomas Mockler
Vice President
Standard & Poor's Corp.

Bruce W. Morrison
Vice President
Marketing of Advanced Systems
Westinghouse Electric Corp.

James Mulvney
Manager, Regional Utility Data System
Electric Power Research Institute

Dave J. Roberts
Manager for Strategic Planning
GPU Service Corp.

Fred Schweppe
Professor
Electrical Engineering Department
Massachusetts Institute of Technology

John L. Seelke
Director, Strategic Planning
Florida Power & Light

Sam Shepard
Director
Generation Planning
Southern Co. Services, Inc.

Dwain F. Spencer
Vice President
Advanced Power Systems
Electric Power Research Institute

Rodney Stevenson
Professor
Graduate School of Business
University of Wisconsin

Andrew Varley
Commissioner
Iowa Commerce Commission

Carl Weinberg
Chief
Department of Engineering and Research
Pacific Gas & Electric Co.

H. D. Williamson
Vice President for Planning
Hawaiian Electric Co., Inc.

David R. Wolcott
Project Associate
New York State Energy Research and Development Authority

Workshop #2: Load Management

John Dorsey
Chief Engineer
Maryland Public Service Commission

Bernard Hastings
Engineer
Interconnection and Load Management
Detroit Edison Co.

Dick Preston
Regional Sales Manager
Scientific Atlanta

Veronika Rabl
Project Manager
Load Management Technology
Electric Power Research Institute

Tom Stickels
San Diego Gas & Electric Co.

John Tengdin
Manager
Load Management Products
General Electric Co.

Kyle Wilcutt
Manager
Marketing and Technical Services
Southern Co. Services, Inc.

Workshop #3: Cost and Performance of New Electricity Generating Technologies

James W. Bass III
Project Engineer
AFBC Technical Services Section
Tennessee Valley Authority

Robert A. Bell
Vice President
Consolidated Edison Inc.

Elliot Berman
Chief Scientist
ARCO Solar Inc.

Chris Bluemle
Senior Engineer
Southern California Edison

Peter B. Bos
President
Polydyne Corp.

J. J. Buggy
Manager
Fuel Cell Programs
Westinghouse Electric

Jay Carter, Jr.
President
Carter Systems

Thomas A. V. Cassel
President
Technecon Consulting Group, Inc.

Carel DeWinkel
Program Manager
Wind Energy Program
Wisconsin Power & Light

G. P. James Dehlson
President
Zond Wind Resource Development

Charles M. Finch
Systems Engineer
Solar Programs
McDonnel Douglas Astronautics

Richard W. Foster-Pegg
Consultant
Westinghouse Electric

Robert Greider
Director and Past President
Geothermal Resources International

Ray Hallett
Director
Solar Programs
McDonnell Douglas Astronautics

Walter A. Hansen
Senior Technical Advisor
Advanced Energy Systems
Babcock & Wilcox

Robert Lacy
Manager
Heber Binary Project Department
San Diego Gas & Electric Co.

Janos Laszlo
ASME Congressional Fellow
United States Senate

Peter Lewis
Manager of Energy Utilization R&D
Public Service Electric & Gas

Roger Little
President
Spire Corp.

Paul Maycock
President
Photovoltaics Energy System

William J. McGuirk
Manager
Research Program Department
Arizona Public Service Co.

Tom Morton
Senior Manager, Process Engineering
Advanced Technology Division
Fluor Engineers & Constructors, Inc.

Lawrence M. Murphy
Group Manager, Solar Systems Engineering
Solar Energy Research Institute

Eric J. Oakes
President
Pyropower Corp.

Nick Patapoff
Research and Development
Southern California Edison

Don I. Plumley
Manager
Coal Gasification Combined Cycle Program
General Electric Co.

Ted J. Pollaert
Director of Marketing, Synfuels
Lurgi Corp.

J. Lynn Rasband
Manager
Planning Department
Utah Power & Light

Jeff Serfass
Executive Director
Fuel Cell Users Group

Stan Stys
Vice President
Brown-Boveri Corp.

Russell A. Thompson
Manager, Business Planning
Power Systems Division
United Technologies

William Vachon
President
W. A. Vachon & Associates

Henry Vadie
Supervisor
Tactical Planning, Corporate Planning
Houston Lighting & Power

Charles J. Warde
Vice President
Research and Development
Energy Development Associates

Technologies for Surface Mine Reclamation on Western Federal Lands

James J. Stukel, *Chair*
Director, Public Policy Programs
College of Engineering
University of Illinois

George Davis
Senior Hydrogeologist
S. S. Papadopulos & Associates

Tim Gallagher
Senior Administrative Assistant
Office of Governor Schwinden, Montana

L. Thomas Galloway, Esq.
Galloway & Greenberg

Sheridan Glen
Assistant Vice President
Arch Mineral Corp.

Nick Golder
Consultant

Pat Holderness
Commissioner
Routt County, Colorado

Carolyn Johnson
Staff Geologist
Natural Resources Defense Council

Frank Kottlowski
Director
New Mexico Bureau of Mines and Mineral Resources

George Land
Director, Technology Assessment
AMAX Coal Co.

Cyrus McKell
Vice President, Research
Native Plants, Inc.

Lyle Randen
Administrator, Land Quality Division
Wyoming Department of Environmental Quality

Patrick Sweeney
Regional Director
Western Organization of Resource Councils

Lauri M. Zell
Director, Government Affairs
Mining and Reclamation Council of America

Ex Officio:
Raymond Fritz
Deputy Chief
Division of Ecological Services
Fish and Wildlife Service
U.S. Department of the Interior

Dan Kimball
Air and Water Quality Division
National Park Service

Al Klein
Administrator, Western Technical Center
Office of Surface Mining
U.S. Department of the Interior

Workshop: Environmental Protection in the Federal Coal Leasing Program

Dave Alberswerth
Resource Specialist
National Wildlife Federation

Daniel P. Baker
Manager, Government Affairs
Consolidation Coal Co.

Paige B. Beville
Senior Permit Specialist
Anaconda Minerals Co.

Carol Condie
New Mexico Archaeological Council

Maggie Fox
Southwest Region Representative
Sierra Club

Allan Garnaas
Consultant

Sheridan Glen
Assistant Vice President
Arch Mineral Corp.

Robert Jackson
Director, Corporate Affairs
Sunbelt Mining Co., Inc.

Dewitt John
Assistant Director
Colorado Department of Natural Resources

August Keller
Director
North Dakota Energy Development Impact Office

Laura King
Counsel
Natural Resources Defense Council

Leslie Lehmann
Manager, Government and Public Affairs
Northern Energy Resource Co.

Lorin Nielsen
Associate Director for Energy and Minerals
Utah Department of Natural Resources

Charles Rech
Land Manager
Meridian Land & Minerals Co.

Michael Rieber
Department of Mining and Geological Engineering
College of Mines
University of Arizona

Charles Roybal
Deputy Secretary
New Mexico Energy & Minerals Department

Mel Schilling
Chief, Division of Mining Analysis
Western Technical Center
Office of Surface Mining

Christopher Seglem
President
Colorado Westmoreland, Inc.

Pat Sweeney
Regional Director
Western Organization of Resource Councils

Tom Walker
Chief, Division of Solid Mineral Leasing
Bureau of Land Management

Geoff Webb
Legislative Representative
Friends of the Earth

Mark Welsh
Mining Project
Colorado Open Space Council

Warren White
Planning Coordinator
State of Wyoming

International Security and Commerce Program

International Competitiveness in Electronics Advisory Panel

Katherine D. Seelman, *Chair*
Consultant

Jack C. Acton
Executive Vice President
Kennemetal Inc.

Steve Beckman
Research Analyst
Industrial Union Department
AFL-CIO

A. Terry Brix
President
Temar Ltd.

Richard P. Case
Lab Director
IBM Corp.

Ruth Schwartz Cowan
Associate Professor of History
SUNY-Stony Brook

William Kay Daines
Executive Vice President
American Retail Federation

Leonard Dietch
Vice President, Product Development
Zenith Radio Corp.

Isaiah Frank
William Clayton Professor of International Economics
The Johns Hopkins University

F. Willard Griffith, II
President and Chief Executive Officer
GC International

Robert R. Johnson
Senior Vice President
Engineering and Information Systems
Energy Conversion Devices, Inc.

Richard A. Kraft
President
Matsushita Industrial Co.

E. Floyd Kvamme
Vice President and General Manager
National Advanced Systems

Geraldine McArdle
McArdle Associates

Charles Phipps
Vice President
SemiConductor Group
Texas Instruments, Inc.

K. M. Poole
Head, Integrated Circuit Planning Department
Bell Telephone Laboratories

Benjamin M. Rosen
Partner
Sevin Rosen Management Co.

Kate Wilhelm
Author

Robert B. Wood
Director of Research
International Brotherhood of Electrical Workers

Michael Y. Yoshino
Professor of Business Administration
Harvard Business School

Command, Control, Communications, and Intelligence Systems (C^3I) Advisory Panel

John S. Toll, *Chair*
President
University of Maryland

Lew Allen, Jr.
General, USAF (retired)
Director
Jet Propulsion Laboratory

Al Babbitt
Vice President and General Manager
Command Systems
IBM Corp.

Neil Birch
President
Birch Associates, Inc.

Gerald Dinneen
Vice President
Science and Technology
Honeywell

Robert R. Everett
President
The Mitre Corp.

Edward Goldstein
Assistant Vice President
Financial Management
AT&T Co.

Arnold Horelick
The Rand Corp.

William Kaufman
Professor of Political Science
Massachusetts Institute of Technology

Glenn Kent
Lt. General, USAF (retired)
The Rand Corp.

Isaac C. Kidd, Jr.
Admiral, USN (retired)

Kostas J. Liopiros
Consultant

William Perry
Managing Partner
Hambrecht & Quist

Jack Ruina
Professor of Electrical Engineering
Massachusetts Institute of Technology

Brent Scrowcroft
Lt. General, USAF (retired)

Walter Slocombe
Kaplan & Drysdale

Leon Sloss
President
Leon Sloss Associates

John D. Steinbruner
Director
Foreign Policy Studies Program
The Brookings Institution

John Stenbit
Vice President
Requirements & Group Development
TRW Defense Systems Group

Jerome B. Wiesner
President Emeritus
Massachusetts Institute of Technology

International Cooperation and Competition in Space Advisory Panel

Paul Doty, *Chair*
Director, Center for Science and International Affairs
Harvard University

Benjamin Bova
President
National Space Institute

Robert Evans
Vice President
IBM Corp.

Robert A. Frosch
Vice President, Research
General Motors Research Laboratories

Mireille Gerard
Administrator, Corporate and Public Programs
American Institute of Aeronautics and Astronautics

Ivan Getting
Consultant

Benjamin Huberman
Vice President
Consultants International Group Inc.

John Mayo
Vice President
Bell Laboratories

Walter McDougall
Associate Professor of History
Woodrow Wilson Space and Science Division
National Air and Space Museum
Smithsonian Institution

John L. McLucas
President
COMSAT World Systems Division

Martin Menter
Brigadier General (retired)

Arthur Morrissey
Director, Future Systems
Martin Marietta Aerospace

Fred Raynes
Vice President
Grumman International Inc.

Gary Saxonhouse
Professor of Economics
University of Michigan

Jerome Simonoff
Vice President
CitiCorp Industrial Credit, Inc.

Leonard Sussman
Executive Director
Freedom House

John Townsend
President
Fairchild Space & Electronics Co.

Laurel Wilkening
Director
Lunar and Planetary Laboratory
University of Arizona

Elizabeth Young
President
Public Service Satellite Consortium

Technology Transfer to the Middle East Advisory Panel

George Bugliarello, *Chair*
President
Polytechnic Institute of New York

Fouad Ajami
Professor
School of Advanced International Studies
The Johns Hopkins University

J. S. Dana
Consultant and Former President
South Hampton Refining Co.

Farouk El-Baz
Vice President
International Development
ITEK Optical Systems

Ragaei El-Mallakh
Professor
International Research Center for Energy and Development
University of Colorado

James A. Finneran
Vice President
Worldwide Process Operations
M. W. Kellogg Co.

Eric Glasscott
President
Telephone & General Services, Inc.

Carl N. Hodges*
Director
Environmental Research Laboratory
University of Arizona

Gary Hufbauer
Consultant
Institute for International Economics

J. C. Hurewitz
Professor
Director of Middle East Institute
Columbia University

Charles Issawi
Professor
Near East Studies
Princeton University

T. R. McLinden
Manager, Special Projects
Transworld Airlines

*Ex-officio member from the OTA Technology Assessment Advisory Council.

Joseph Nye
Professor
Kennedy School of Government
Harvard University

Anthony Pascal
Consultant
The Rand Corp.

William H. Pickering
President
Pickering Associates Corp.

William B. Quandt
Senior Fellow
The Brookings Institution

Joseph J. Sisco
Consultant
Sisco Associates

Joseph S. Szyliowicz
Professor
Graduate School of International Studies
University of Denver

Ted Taylor
Consultant
Appropriate Solar Technology Institute

William L. Weirich
Medical Advisor
Hospital Corp. of America

Sam Wells
Director
International Security Studies Program
The Wilson Center
Smithsonian Institution

New Ballistic Missile Defense Technologies Advisory Panel

Guyford Stever, *Chair*
President
Universities Research Associates

Solomon Buchsbaum
Executive Vice President
Customers Systems
AT&T Bell Laboratories

Ashton Carter
Research Fellow
Center for International Studies
Massachusetts Institute of Technology

Robert Clem
Director of Systems Sciences
Sandia National Laboratories

Sidney D. Drell
Deputy Director
Stanford Linear Accelerator Center

Daniel Fink
President
D. J. Fink Associates Inc.

Richard L. Garwin
IBM Fellow
Thomas J. Watson Research Center
IBM Corp.

Noel Gayler
Admiral (U.S. Navy-retired)
American Committee on East-West Accord

Daniel Graham
Lt. General (U.S. Army-retired)
High Frontier

Colin Gray
President
National Institute for Public Policy

George Jeffs
President
North American Space Operations

David Jones
General (U.S. Air Force-retired)

Michael M. May
Associate Director at Large
Lawrence Livermore National Laboratory

Robert S. McNamara
Former Secretary of Defense

H. Alan Pike
Program Manager
Space Stations
Lockheed Missiles & Space Co.

Robert Selden
Associate Director for Theoretical and Computation Physics
Los Alamos National Laboratory

Marshall D. Shulman
Director, Harriman Institute for Advanced Study of the Soviet Union
Columbia University

Gerard C. Smith
President
Consultants International Group, Inc.

Sayre Stevens
Vice President
System Planning Corp.

John Toomay
Major General (U.S. Air Force-retired)

Seymour Zeiberg
Vice President
Research and Engineering Operations
Martin Marietta Aerospace

Workshop: Arms Control in Space*

David S. Brandwein
Director, Intelligence Analysis Department
System Planning Corp.

Paul Brown
Assistant Associate Director for Arms Control
Lawrence Livermore National Laboratory

Robert W. Buchheim
Consultant

McGeorge Bundy
Professor, Department of History
New York University

Albert Carnesale
Professor, Kennedy School of Government
Harvard University

Ashton Carter
Center for Science and International Affairs
Kennedy School of Government
Harvard University

Richard L. Garwin
IBM Fellow
Thomas J. Watson Research Center
IBM Corp.

Alex Gliksman
Professional Staff Member
Foreign Relations Committee
United States Senate

Donald L. Hafner
Consultant

Robert H. Kupperman
Executive Director for Science and Technology and Senior Associate
Center for Strategic and International Studies
Georgetown University

Steven Maaraene
Strategic Programs
Los Alamos National Laboratory

Michael M. May
Associate Director at Large
Lawrence Livermore National Laboratory

Keith Payne
Executive Vice President and Director of National Security Studies
National Institute for Public Policy

John E. Pike
Associate Director for Space Policy
Federation of American Scientists

Victor Reis
Corporate Vice President
Science Applications, Inc.

Walter Slocombe
Caplin & Drysdale

John D. Steinbrunner
Director, Foreign Policy Studies Program
The Brookings Institution

Henry B. Stelling, Jr.
Lt. General (U.S. Air Force-retired)
Vice President and Center Director
Advanced Development Center
Defense Electronic Operations
Rockwell International

Sayre Stevens
Vice President
National Security Research Group
System Planning Corp.

Industry, Technology, and Employment Program

Technologies To Reduce U.S. Materials Import Vulnerability Advisory Panel

Arden Bement
Vice President, Technical Resources
TRW, Inc.

Edwin Clark
Senior Associate
Conservation Foundation

Tom Clough
Director of Technology
Atlantic Richfield Co.

Robert G. Dunn
Senior Vice President
AMAX Metals Group

*Several participants were originally invited as alternates for others who could not attend the entire workshop.

Robert Ellsworth
President
Robert Ellsworth & Co.

Michael E. Fisher
Professor of Chemistry, Physics and Mathematics
Cornell University

Herbert H. Kellogg
Professor of Extractive Metallurgy
Columbia University

Hans Landsberg
Senior Fellow
Resources for the Future

Jessica Tuchman Mathews
Vice President
World Resources Institute

William A. Owczarski
Manager, Technical Planning
Pratt & Whitney Aircraft Group

Walter S. Owen
Professor of Materials Science
Massachusetts Institute of Technology

R. Byron Pipes
Director, Center for Composite Materials
University of Delaware

R. K. Pitler
Senior Vice President and Technical Director
Allegheny-Ludlum Research Center

Dennis Readey
Head, Department of Ceramic Engineering
The Ohio State University

James K. Sebenius
Assistant Professor
John F. Kennedy School of Government
Harvard University

Albert Sobey
Director, Energy Economics
General Motors Corp.

Alex Zucker
Associate Director
Oak Ridge National Laboratory

Cleanup of Uncontrolled Hazardous Waste Sites Under Superfund Advisory Panel

Martin Alexander, *Chair*
Department of Agronomy
Cornell University

K. W. Brown
Professor of Soil and Crop Sciences
Texas A&M University

Morton Corn
Professor and Director
Division of Environmental Health Engineering
School of Hygiene and Public Health
The Johns Hopkins University

Bonnie L. Exner
Consultant
Governor's Lowry Landfill Monitoring Committee
State of Colorado

Ted Greenwood
Associate Professor of Political Science
Institute of War and Peace Studies
Columbia University

Linda E. Greer
Science Associate
Environmental Defense Fund

Robert G. Kissell
Senior Consultant Engineering Department
E. I. du Pont de Nemours & Co.

Gary E. Kovall
Manager, Environmental, Legislative and Regulatory Affairs
ARCO Petroleum Products Co.

Stephen U. Lester
Consultant
Citizens Clearinghouse for Hazardous Waste

Adeline G. Levine
Professor of Sociology
State University of New York at Buffalo

Randy M. Mott
Breed, Abbott & Morgan

Norman H. Nosenchuck
Director
Division of Solid and Hazardous Waste
New York State Department of Environmental Conservation

James T. O'Rourke
Senior Vice President, Industrial Group
Camp Dresser & McKee, Inc.

James W. Patterson
Professor and Chairman
Pritzker Department of Environmental Engineering
Illinois Institute of Technology

Robert Repetto
Senior Associate
World Resources Institute

Bernard L. Simonsen
Vice President, Administration
IT Corp.

William A. Wallace
Director
Solid and Hazardous Waste Management
CH2M HILL

Technology and Structural Unemployment: Retraining Adult Displaced Workers: Advisory Panel

Joseph Weizenbaum, *Chair*
Professor
Department of Electrical Engineering and Computer Science
Massachusetts Institute of Technology

Kathy Alessandro
Director of Employment and Training
Downriver Community Conference

Paul Barton
President
National Institute for Work and Learning

Marc Bendick
Senior Research Associate
The Urban Institute

Barry Bluestone
Senior Research Associate and Professor of Economics
Social Welfare Research Institute
Boston College

Paul Boyer
Professor
History Department
University of Wisconsin-Madison

Dennis C. Carey
Director
State and Local Government Consulting
Hay Associates

Dick Greenwood
Special Assistant to the International President
International Association of Machinists and Aerospace Workers

Donald Hancock
Professor
Department of Political Science
Vanderbilt University

Carol Hollenshead
Director of Administrative Services, Planning, and Development
School of Nursing
The University of Michigan

Robert Karasek
Professor
Department of Industrial and Systems Engineering
Engineering School
University of Southern California

C. Van Kirby
Director, Manufacturing Training, North America
IBM Corp.

Sar Levitan
Director
Center for Social Policy Studies
The George Washington University

Robert Machin
Manager
Human Resources Programs
Owens Illinois, Inc.

Jill Miller
Executive Director
Displaced Homemakers Network

Vi Traynor
Program Manager
Vocational Education Services
Control Data Corp.

Elizabeth Useem
Professor
Department of Sociology
University of Massachusetts—Harbor Campus

Gary Wuslich
Senior Manager
Industrial Relations
Jones & Laughlin Steel Corp.

HEALTH AND LIFE SCIENCES DIVISION

Biological Applications Program

Commercial Biotechnology: An International Analysis Advisory Panel

Michael Hooker, *Chair*
President
Bennington College

Howard Bremer
Patent Counsel
Wisconsin Alumni Research Federation

Robert Fildes
President
Cetus Corp.

Julian Gresser
Professor, Program in Science, Technology, and Society
Massachusetts Institute of Technology

Ralph Hardy
Director, Life Sciences
Central Research and Development
E. I. du Pont de Nemours & Co.

Zsolt Harsanyi
Vice President, Biotech Group
E. F. Hutton

Peter Hutt
Covington & Burling

David Jackson
Scientific Director
Genex Corp.

William Maxon
Group Manager, Fermentation Products Production
Upjohn Co.

Laura Meagher
Acting Administrator
North Carolina Biotechnology Center

Robert R. Miller
Director, International Business Courses
University of Houston

Dorothy Nelkin
Professor, Program on Science, Technology, and Society
Cornell University

Norman Oblon
Oblon, Fisher, Spivak, McClelland & Maier

David Padwa
Chairman of the Board
Agrigenetics

David Parkinson
Director of Occupational Medicine Program
University of Pittsburgh

Phillip A. Sharp
Professor of Biology
Massachusetts Institute of Technology

William J. Whelan
Chairman, Biochemistry
School of Medicine
University of Miami

John Zysman
Director, Roundtable for International Economics
University of California, Berkeley

Technology and Aging in America Advisory Panel

Robert Binstock, *Chair*
Director, Policy Center on Aging
Brandeis University

Ray Bartus
Group Leader of Geriatrics
Medical Research Division
Lederle Laboratories

Robert Berliner
Dean, School of Medicine
Yale University

Robert Butler
Chairman, Department of Geriatrics and Adult Education
Mt. Sinai Medical Center

Robert Clark
Associate Professor
Department of Economics and Business
North Carolina State University

Lee Davenport
Senior Vice President and Chief Scientist (retired)
GTE Corp.

Ken Dychtwald
President
Dychtwald & Associates

Caleb Finch
Professor of Biological Sciences and Gerontology
University of Southern California

Velma Murphy Hill
Director
Civil and Human Rights Division
Service Employees International Union

Robert L. Kane
Senior Researcher
The Rand Corp.

Paul A. Kerschner
Associate Director for Programs, Legislation and Development
American Association of Retired Persons

Maggie Kuhn
Founder and National Convener
Gray Panthers

Matt Lind
Vice President
Corporate Planning and Research
The Travelers Insurance Co.

Robert G. Lynch
Vice President, Marketing Planning
GTE Corp.

Mathy D. Mezey
Director
Teaching Nursing Home Program
University of Pennsylvania

Hamish Munro
Professor of Medicine and Nutrition
Tufts University

Bernice Neugarten
Professor of Education and Sociology
Northwestern University

Sara Rix
Research Coordinator
The Women's Research and Education Institute

Pauline Robinson
Research Professor of Gerontology
University of Southern California

John Rowe
Chief of Geriatrics
Beth Israel Hospital

Bert Seidman
Department of Occupational Safety, Health and Social Security
AFL-CIO

Jacob Siegel
Senior Researcher
Center for Population Research
Georgetown University

Workshop: Human Gene Therapy

W. French Anderson
Chief, Laboratory of Molecular Hematology
National Heart, Lung, and Blood Institute

Lori B. Andrews
Research Attorney
American Bar Foundation

James E. Bowman
Professor of Pathology and Medicine
University of Chicago

John C. Fletcher
Assistant for Bioethics
Warren G. Magnuson Clinical Center
National Institutes of Health

Theodore Friedman
Professor of Pediatrics
School of Medicine
University of California at San Diego

Ola Huntley
Board of Directors
Sickle Cell Self-Help

Judith A. Johnson
Analyst in Life Sciences
Science Policy Research Division
Congressional Research Service
Library of Congress

Horace Judson
Henry R. Luce Professor
Writing Seminars
The Johns Hopkins University

Henry Miller
National Center for Drugs and Biologics
Food and Drug Administration

J. Robert Nelson
Professor of Theology
Boston University

Nanette Newell
Director of Research Administration
Calgene, Inc.

Robert Nicholas
Staff Director
Subcommittee on Investigations and Oversight
Committee on Science and Technology
U.S. House of Representatives

Albert Rosenfeld
Consultant on Future Programs
March of Dimes

Seymour Siegel
Ralph Simon Professor of Ethics and Theology
Jewish Theological Seminary of America

Carol Struckmeyer
Genetic Associate and Program Coordinator
New Hampshire Genetic Services Program

Bernand Talbot
Acting Director
National Institutes of Allergy and Infectious Diseases

Leroy Walters
Director, Center for Bioethics
Kennedy Institute of Ethics
Georgetown University

Alternatives to Animal Use in Testing and Experimentation Advisory Panel

Arthur L. Caplan, *Chair*
Associate for the Humanities
Hastings Center

Perrie M. Adams
Professor of Psychiatry
Department of Psychiatry and Behavioral Research
University of Texas

Melvin Balk
Vice President and Scientific Director
Charles River Breeding Laboratories, Inc.

Earle W. Brauer
Vice President, Medical Affairs
Revlon Research Center

David J. Brusick
Vice President
Biological Safety Evaluation Directorate
Litton Bionetics Inc.

G. Gilbert Cloyd
Director
Human and Environmental Safety Division
Miami Valley Laboratories
Procter & Gamble Co.

W. Jean Dodds
Chief, Laboratory of Hematology
Division of Laboratories and Research
New York State Department of Health

Kurt Enslein
President
Health Designs, Inc.

Alan M. Goldberg
Director, The Johns Hopkins Center for Alternatives to Animal Testing

Richard M. Hoar
Associate Director
Division of Toxicology and Pathology
Hoffmann-La Roche, Inc.

Peter Hutt, Esq.
Covington & Burling

Connie Kagan
Animal Political Action Committee

Ronald Lamont-Havers
Director, Research Administration
Massachusetts General Hospital

John McArdle
Associate Director
Institute for Study of Animal Problems
Humane Society of the United States

Robert A. Neal
President
Chemical Industry Institute of Toxicology

J. Wesley Robb
Professor of Religion
School of Religion
Professor of Bioethics
School of Medicine
University of Southern California

Andrew N. Rowan
Assistant Dean for New Programs
School of Veterinary Medicine
Tufts University

Jeri Sechzer
Associate Professor
Department of Psychiatry
The New York Hospital—Cornell Medical Center

Henry Spira
Director
Coalition to Abolish the LD50 and Draize Tests

Reproductive Hazards in the Workplace Advisory Panel

Ruth Faden, *Chair*
School of Hygiene and Public Health
The Johns Hopkins University

Joan E. Bertin
Attorney
American Civil Liberties Union

Larry L. Ewing
Division of Reproductive Biology
School of Hygiene and Public Health
The Johns Hopkins University

Ronald D. Hood
Biology Department
The University of Alabama

Vilma R. Hunt
Professor, Environmental Health
Program in Science, Technology, and Society
Massachusetts Institute of Technology

Larry Johnson
Department of Cell Biology
University of Texas Health Science Center at Dallas

Norman W. Klein
Department of Animal Genetics
University of Connecticut

James E. Lockey
Director, Occupational Medical Clinic
Rocky Mountain Center for Occupational and Environmental Health
University of Utah Medical Center

David C. Logan
Clinical Toxicologist
Corporate Medical Department
Mobil Oil Corp.

Junius C. McElveen, Jr.
Attorney
Jones, Day, Reavis & Pogue

Mary-Win O'Brien
Assistant General Counsel
United Steelworkers of America

Neena B. Schwartz
Department of Neurobiology and Physiology
Northwestern University

Judith A. Scott
Associate General Counsel
United Mine Workers of America

Margaret Seminario
Associate Director
Department of Occupational Safety, Health, and Social Security
AFL-CIO

Robert C. Spear
Department of Biomedical and Environmental Health Sciences
School of Public Health
University of California, Berkeley

M. Anne Spence
Professor, Division of Medical Genetics
Neuropsychiatric Institute
Center for the Health Sciences

R. E. Staples
Staff Teratologist
Haskell Laboratory for Toxicology and Industrial Medicine
E. I. du Pont de Nemours & Co.

Jeanne M. Stellman
School of Public Health
Columbia University

John R. Wheeler
Attorney
Standard Oil Co. (Indiana)

Food and Renewable Resources Program

Water-Related Technologies for Sustainable Agriculture in U.S. Arid/Semiarid Lands Advisory Panel

James B. Kendrick, Jr., *Chair*
Vice President
Agriculture and University Services
University of California, Berkeley

Alton A. Adams, Jr.
President
Adams & Associates

Wilbert H. Blackburn
Professor
Department of Range Science
Texas A&M University

William T. Dishman
Rancher
Idaho

Harold E. Dregne
Professor
Department of Plant and Soil Science
Texas Tech University

Chester E. Evans
USDA Research Director (retired)

Larry J. Gordon
Director
Albuquerque Environmental Health Department

Robert M. Hagan
Professor
Department of Land, Air, and Water Resources
University of California, Davis

David E. Herrick
U.S. Forest Service (retired)
Western Agricultural Research Committee
Colorado

Helen Ingram
Professor
Department of Government
University of Arizona, Tucson

Cyrus McKell
Director of Research
Plant Resources Institute
Utah

Michael F. McNulty
Director
Tucson Active Management Area
Arizona Department of Water Resources

Milton E. Mekelburg
President
National Association of Soil Conservation Districts
Colorado

Clifford J. Murino
President
Desert Research Institute
Nevada

Alice Parker
Farmer/Rancher
Washington

Cynthia Reed
Rancher
South Dakota

Luis Torres
Program Director
American Friends Service Committee
Northern New Mexico

Casey E. Westell, Jr.
Director of Industrial Ecology
Tenneco, Inc.
Texas

Norman K. Whittlesey
Professor
Department of Agricultural Economics
Washington State University, Pullman

Technologies To Sustain Tropical Forest Resources Advisory Panel

Leonard Berry, *Chair*
Research Professor
Center for Technology, Environment, and Development
Clark University

Eddie Albert
Conservationist

Hugh Bollinger
Director
Plant Resources Institute

Robert Cassagnol
Member, Technical Committee
CONAELE

Robert Cramer
Former President
Virgin Islands Corp.

Gary Eilerts
Operations Representative
Appropriate Technology International

John Ewel
Associate Professor
Department of Botany
University of Florida, Gainesville

Robert Hart
Agronomist
Winrock International

Susanna Hecht
Assistant Professor
Department of Geography
University of California, Los Angeles

Marilyn Hoskins
Lecturer
Department of Sociology
Virginia Polytechnic Institute

Norman Johnson
Vice President, North Carolina Region
Weyerhaeuser Co.

Jan Laarman
Assistant Professor
Department of Forestry
North Carolina State University

Chuck Lankester
Forester
U.N. Development Programme

Robert Owen
Chief Conservationist (retired)
Trust Territory of the Pacific Islands

Christine Padoch
Assistant Professor
Institute of Environmental Studies
University of Wisconsin, Madison

Allen Putney
Principal Investigator
Eastern Caribbean Natural Area Management Program
West Indies Lab

Jeff Romm
Assistant Professor
Department of Forestry
University of California, Berkeley

John Terborgh
Professor
Department of Biology
Princeton University

Henry Tschinkel
Forestry Advisor
Regional Office for Central American Programs
Agency for International Development
U.S. Department of State

Technology, Public Policy, and the Changing Structure of American Agriculture Advisory Panel

Frank Baker
Director
International Stockmen's School
Winrock International Livestock Research and Training Center

James Bonnen
Professor
Department of Agricultural Economics
Michigan State University

William Brown
Chairman of the Board
Pioneer Hi-Bred International, Inc.

Frederick Buttel
Associate Professor
Department of Rural Sociology
Cornell University

Willard Cochrane
Consultant

Jack Doyle
Director
Agricultural Resources Project
Environmental Policy Center

Marsha Dudden
Dudden Farms, Inc.

Walter Ehrhardt
Blue Ridge Farms

Dean Gillette
Professor
Engineering Department
Harvey Mudd College

Rogert Granados
Executive Director
La Cooperative

Richard Harwood
Director of Research
Rodale Research Center

Ralph Hofstad
President
Land-O'Lakes Cooperative

Charles Kidd
Dean, College of Engineering Science, Technology, and Agriculture
Florida A&M University

Robert Lanphier III
Chairman of the Board
Dickey-John Corp.

Edward Legates
Dean, College of the Agriculture and Life Sciences
North Carolina State University

John Marvel
President and General Manager
Research Division
Monsanto Agriculture Products Co.

Donella Meadows
Adjunct Professor
Resources Policy Center
Dartmouth College

Don Paarlberg
Consultant

Don Reeves
Consultant
Interreligious Taskforce on U.S. Food Policy

Milo Schanzenbach
Schanzenbach Farms

Workshop #1: Economic Relationships Between Agricultural Technology and Structure

Boyd Buxton
Research Leader
Economic Research Service
Department of Agriculture and Applied Economics
University of Minnesota

B. R. Eddleman
National Agricultural Research Planning and Analysis
State Agricultural Experiment Stations

James W. Richardson
Consultant

Wesley Sundquist
Professor, Department of Agriculture and Applied Economics
University of Minnesota

Workshop #2: Animal Technology

C. Eugene Allen
College of Agriculture
University of Minnesota

Howard Bachrach
ARS/USDA
Plum Island Animal Disease Center

John Campbell
North Platte Agricultural Experiment Station

Stanley E. Curtis
Department of Animal Science
University of Illinois

James R. Fischer
Department of Agriculture Engineering
University of Missouri

William Hansel
Department of Animal Science
Cornell University

B. I. Osburn
School of Veterinary Medicine
University of California

Wilson G. Pond
ARS/USDA
Roman L. Hruska U.S. Meat Animal Research Center

Workshop #3: Agricultural Research and Extension

George Hyatt
Consultant

Ronald Knutson
Professor, Agricultural and Food Policy Center
Texas A&M University System

Roy Lovvorn
Consultant

Fred White
Professor, Department of Agricultural Economics
University of Georgia

Workshop #4: Soil and Water Technology

Martin Alexander
Professor of Soil Microbiology
Department of Agronomy
Cornell University

Joseph A. Berry
Carnegie Institution of Washington

Larry L. Boersma
Professor of Soil Physics
Department of Soil Science
Oregon State University

C. H. Davis
Director of Chemical Division
National Fertilizer Development Center
Tennessee Valley Authority

George R. Foster
National Soil Erosion Laboratory
Purdue University

Charles Francis
Department of Agronomy
University of Nebraska

Richard Harwood
Director of Research
Rodale Research Center

William Liebhardt
Rodale Research Center

Workshop #5: Plant Technology

J. A. Browning
Department of Plant Sciences
Texas A&M University

Robert Fraley
Monsanto Agricultural Co.

George Kennedy
Department of Entomology
North Carolina State University

Chester G. McWhorter
Chief, Southern Weed Science Laboratory
ARS/U.S. Department of Agriculture
Delta State Research Center

Louis G. Nickell
Vice President of Research and Development
Velsicol Chemical Co.

Workshop #6: Animal Technology

C. Eugene Allen
Professor
College of Agriculture
University of Minnesota, St. Paul

Howard Bachrach
Consultant
ARS-USDA
Plum Island Disease Center

Roger Breeze
Director of Research
College of Veterinary Medicine
Washington State University

Keith Brown
Professor, Department of Poultry Science
Ohio State University

John Campbell
Professor
North Platte Agricultural Experiment Station

Dennis Campion
Research Leader
Animal Physiology Research
Richard B. Russell Research Center

B. Joe Conlin
Extension Dairy Specialist
University of Minnesota, St. Paul

Larry Corah
Extension Beef Cattle Specialist
Kansas State University

Nicholas Cross
President
Cattle Code America

Stanley E. Curtis
Professor, Department of Animal Science
University of Illinois, Urbana

James R. Fischer
Research Leader
Department of Agriculture Engineering
University of Missouri, Columbia

Harold Hafs
Vice President
Agricultural Research
Merck Institute for Therapeutic Research

William Hansel
Liberty Hyde Bailey Professor of Animal Physiology
Department of Physiology
New York State College of Veterinary Medicine
Cornell University

Maynard Hogberg
Extension Swine Specialist
Michigan State University

Alan Holiday
Vice-President for Research and Development
Farmland Industries

Keith Hora
Farmer
Iowa

Ronald Knutson
Professor, Department of Agricultural Economics
Texas A&M University

Sid E. Kunz
Research Leader
U.S. Livestock Insects Laboratory

Charles McGinnis
Farmer
South Carolina

John McKnight, Jr.
Farmer
Arkansas

A. J. Muehling
Professor
Agricultural Engineering Extension Specialist
Agricultural Engineering Department
University of Illinois, Urbana

John Nye
Professor, Agricultural Engineering Department
Purdue University

P. A. Oltenacu
Associate Professor of Systems Analysis
Department of Animal Science
Cornell University

B. I. Osburn
Professor of Pathology and Associate Dean of Research
School of Veterinary Medicine
University of California, Davis

John Paterson
Associate Professor
University of Missouri, Columbia

Wilson G. Pond
Research Leader
ARS-USDA
Roman L. Hruska U.S. Meat Animal Research Center

Rod Preston
Thornston Distinguished Professor
Department of Animal Sciences
Texas Tech University

Hoyle B. Puckett
Research Leader
ARS-USDA
University of Illinois, Urbana

Allan Rahn
Associate Professor
Department of Animal Science
Michigan State University

Dave Reed
Director of Clinical Research and Immunology
Molecular Genetics, Inc.

William Riddle
Research Leader
Food and Agricultural Economics
Battelle Columbus Laboratories

Marvin Rohlf
Vice President
Director of Research and Nutrition
Golden Sun Feeds

John V. Shutze
Head, Extension Poultry Science
University of Georgia, Athens

Tom Sporleder
Professor
Department of Agricultural Economics
Texas A&M University

R. H. Strickler
President
ROCCO Enterprises, Inc.

Roy Van Arsdall
Economist
ERS-USDA
University of Illinois, Urbana

Harold Wilcke
Consultant
Ralston-Purina

Workshop #7: Plant, Soil, and Water Technology

Delmar Akerlund
Farmer
Nebraska

Martin Alexander
Professor of Soil Microbiology
Department of Agronomy
Cornell University

Joseph A. Berry
Staff Member
Plant Biology Department
Carnegie Institution of Washington

Larry L. Boersma
Professor of Soil Physics
Department of Soil Science
Oregon State University

J. A. Browning
Chairman, Department of Plant Sciences
Texas A&M University

Bill Burrows
Manager
Product Systems Research
Deere & Co.

John A. Chapman
Vice President
Engineering, Irrigation Division
Valmont Industries

Louie J. Chapman
Head, Extension Agronomy
Auburn University

C. H. Davis
Director of Chemical Division
National Fertilizer Development Center
Tennessee Valley Authority

Lynn Forster
Associate Professor
Department of Agricultural Economics and Rural Sociology
Ohio State University

George R. Foster
Hydraulic Engineer
National Soil Erosion Lab
Purdue University

Robert Fraley
Manager
Plant Molecular Biology Group
Monsanto Agriculture Products Co.

Charles Francis
Professor, Department of Agronomy
University of Nebraska, Lincoln

Nicholas M. Frey
Director
Department of Bio-Technology Research
Pioneer Hi-Bred, Inc.

Arthur Gerlow
Economist
Texas A&M University

Don W. Graffis
Professor, Extension Agronomist
University of Illinois, Urbana

W. R. Guthrie
Vice-President
Agricultural Research
Butler Manufacturing Co.

Robert Hall
Assistant Professor
Extension Agronomist
Plant Science Department

Paul Hedin
Research Leader
Chemistry Research Unit
Boll Weevil Research Laboratory
Mississippi State University

Alan Holiday
Vice President for Research and Development
Farmland Industries

Bobby A. Huey
Extension Agronomist
University of Arkansas

Robert Jolly
Associate Professor, Department of Economics
Iowa State University

George Kennedy
Associate Professor, Department of Entomology
North Carolina State University

John Knepler
Manager, Design Engineering
DICKEY-john Corp.

Ron Lacewell
Professor
Department of Agricultural Economics
Texas A&M University

William Liebhardt
Assistant Director
Rodale Research Center

Chester G. McWhorter
Chief
Southern Weed Science Laboratory

Thomas A. Miller
Research Leader
ERS-USDA
Colorado State University

Page W. Morgan
Professor of Plant Physiology
Department of Plant Sciences
Texas A&M University

Louis G. Nickell
Vice President of Research and Development
Velsicol Chemical Co.

Paul Nixon
Agricultural Engineer
Soil and Water Conservation Research

Bob Nowatzki
Farmer
North Dakota

James H. Palmer
Extension Agronomist
Professor of Agronomy and Soils
Clemson University

Buford Perry
Farmer
Louisiana

William Riddle
Research Leader
Food and Agricultural Economics
Battelle Columbus Laboratories

Bill Robertson
Farmer
Mississippi

Robert L. Schafer
Research Leader
Tillage Research
National Tillage Machinery Laboratory
U.S. Department of Agriculture

Lyle Schertz
Economist
ERS-USDA

James W. Searcy
Research Manager
Stine-Haskell Research Center
E. I. du Pont de Nemours & Co.

B. Stout
Professor
Agricultural Engineering Department
Texas A&M University

E. D. Threadgill
Associate Professor
Agricultural Engineering Department
Coastal Plain Experimental Station
University of Georgia

Larry Williams
Farmer
Illinois

Workshop #8: Technology, Structure, and Rural Communities

Dave Brown
Associate Director
EDD/ERS/USDA

Fred Buttel
Associate Professor
Department of Rural Sociology
Cornell University

David Chicoine
Department of Agricultural Economics
University of Illinois, Urbana

Cornelia Flora
Department of Sociology
Kansas State University

Dean MacCannell
Professor, Department of Applied Behavioral Sciences
University of California, Davis

Lyle Schertz
Senior Economist
NED/ERS/USDA

Steve Sonka
Associate Professor
Department of Economics
University of Illinois, Urbana

Louis Swanson
Assistant Professor
Department of Sociology
University of Kentucky, Lexington

Workshop #9: Credit Policy

Peter Barry
Professor, Department of Agricultural Economics
University of Illinois, Urbana

John Brake
Professor, Department of Agricultural Economics
Cornell University

Steve Gabrial
Agricultural Economist
Economic Research Service
U.S. Department of Agriculture

Dave Lins
Associate Professor
Department of Agricultural Economics
University of Illinois, Urbana

Ronald Meekhof
Agricultural Economist
Economist Research Service
U.S. Department of Agriculture

John Penson
Professor, Department of Agricultural Economics
Texas A&M University

Africa Tomorrow: Technological Alternatives to Food Aid Advisory Panel

George Burrill
President
Associates in Rural Development

Charles Francis
Associate Director of Research
Rodale Research, Inc.

E. H. Gilbert
Director
Center for Research on Economic Development
University of Michigan, Ann Arbor

Thomas Hayden
Director, Social Concerns Department
Society of African Missions

James Henson
Director
International Programs Development
Washington State University

Marilyn Hoskins
Department of Sociology
Virginia Polytechnic Institute

Shelly Kessler
Consultant
Urban Resource Systems, Inc.

Carl Lindblad
Agricultural Post-Harvest Technical Specialist
Volunteers in Technical Assistance

Sauveur Mahotiere
Department of Horticulture
Fort Valley State College

Gerald Matlock
Department of Soils, Water and Engineering
University of Arizona, Tucson

Robert McDowell
Department of Animal Science
Cornell University

Uzo Mokwunye
International Fertilizer Development Center

Anita Spring
Department of Anthropology
University of Florida, Gainesville

Health Program

Health Program Advisory Committee

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President
Milbank Memorial Fund

H. David Banta
Deputy Director
Pan American Health Organization

Carroll L. Estes
Chair, Department of Social and Behavioral Sciences
School of Nursing
University of California, San Francisco

Robert Evans
Professor, Department of Economics
University of British Columbia

Rashi Fein
Professor, Department of Social Medicine and Health Policy
Harvard Medical School

Harvey V. Fineberg
Dean, School of Public Health
Harvard University

Patricia King
Professor
Georgetown Law Center

Joyce C. Lashof
Dean, School of Public Health
University of California, Berkeley

Alexander Leaf
Professor of Medicine
Harvard Medical School
Massachusetts General Hospital

Frederick Mosteller
Professor and Chair
Department of Health Policy and Management
School of Public Health
Harvard University

Norton Nelson
Professor, Department of Environmental Medicine
Medical School
New York University

Robert Oseasohn
Associate Dean
University of Texas

Nora Piore
Senior Fellow and Advisor
Advisor to the President
United Hospital Fund of New York

Dorothy P. Rice
Regents Lecturer
Department of Social and Behavioral Sciences
School of Nursing
University of California, San Francisco

Richard K. Riegelman
Associate Professor
George Washington University School of Medicine

Walter L. Robb
Vice President and General Manager
Medical Systems Operations
General Electric

Frederick C. Robbins
President
Institute of Medicine

Rosemary Stevens
Professor
Department of History and Sociology of Science
University of Pennsylvania

Medical Technology and Costs of the Medicare Program Advisory Panel

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Dean, Florence Heller School
Brandeis University

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Vice President
Washington State Hospital Association

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The Robert Wood Johnson Foundation

Jerry Cromwell
President
Health Economics Research

Karen Davis
Professor and Chair
Department of Health Policy and Management
School of Hygiene and Public Health
The Johns Hopkins University

Robert Derzon
Vice President
Lewin & Associates

Howard Frazier
Director, Center for the Analysis of Health Practice
School of Public Health
Harvard University

Cliff Gaus
Director
Center for Health Policy Studies
Georgetown University

Jack Hadley
Co-Director
Center for Health Policy Studies
Georgetown University

Kate Ireland
Chair, Board of Governors
Frontier Nursing Service

Judith Lave
Professor
Department of Health Economics
University of Pittsburgh

Mary Marshall
Member
Virginia House of Delegates

Walter McNerney
Professor
Northwestern University

Morton Miller
President
National Health Council
New York

James Mongan
Executive Director
Truman Medical Center

Seymour Perry
Senior Fellow and Deputy Director
Institute for Health Policy Analysis
Georgetown University Medical Center

Robert Sigmond
Director, Community Programs for Affordable Health Care
Blue Cross/Blue Shield Association

Anne Somers
Professor
Department of Environment and Community and Family Medicine
Princeton University

Paul Torrens
Professor
School of Public Health
University of California, Los Angeles

Keith Weikel
Group Vice President
American Medical International

Federal Policies and the Medical Devices Industry

Richard R. Nelson, *Chair*
Director and Professor
Institute for Social and Political Studies
Yale University

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President
International Numatics, Inc.

Ruth Farrisey
Independent Consultant and Researcher

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Covington & Burling

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Consultant
Applied Electronic Consultants, Inc.

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Kidney Foundation of the Upper Midwest

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Dean, School of Public Health
University of California, Berkeley

Penn Lupovich
Director of Laboratories
Group Health Association

Victor McCoy
National Service Director
Paralyzed Veterans of America

Robert M. Moliter
Manager
Government and Industry Affairs
Medical Systems Division
General Electric

Louise B. Russell
Senior Fellow
The Brookings Institution

Earl J. Saltzgiver
President
Foremost Contact Lens Service, Inc.

Charles Sanders
Vice President
E. R. Squibb & Sons

Rosemary Stevens
Professor
Department of History and Sociology of Science
University of Pennsylvania

Allan R. Thieme
President
Amigo Sales Inc.

Eric von Hippel
Associate Professor of Management
Sloan School
Massachusetts Institute of Technology

Edwin C. Whitehead
Chairman
Technicon Corp.

Health and Safety Control Technologies in the Workplace Advisory Panel

Morton Corn, *Chair*
Professor, Department of Environmental Health Sciences
School of Hygiene and Public Health
The Johns Hopkins University

Duane L. Block
Medical Director
Ford Motor Co.

Richard F. Boggs
Vice President
Organization Resources Counselors, Inc.

Mark R. Cullen
Professor of Statistics
Occupational Medicine Program
School of Medicine
Yale University

Philip E. Enterline
Professor of Biostatistics
School of Public Health
University of Pittsburgh

Melvin W. First
Professor
Department of Environmental Health Sciences
School of Public Health
Harvard University

Matt Gillen
Industrial Hygienist
Amalgamated Clothing and Textile Workers Union

Melvin Glasser
Director
Health Security Action Council

William J. McCarville
Director, Environmental Affairs
Monsanto Co.

Wilbur L. Meier, Jr.
Dean, School of Engineering
Pennsylvania State University

John Mendeloff
Associate Professor
Program in Science, Technology, and Public Affairs
University of California, San Diego

Samuel Milham, Jr.
Section Head, Epidemiology Section
Washington State Department of Social and Health Services

Kenneth B. Miller
Consultant
Occupational Medicine

Ted E. Potter
Environmental Manager
Shepherd Chemical Co.

Milan Racic
Director, Safety and Health
Allied Industrial Workers Union

Mark A. Rothstein
Associate Professor
West Virginia University College of Law

Marilyn Schule
Principal
Centaur Associates

Michael O. Varner
Corporate Manager
Department of Environmental Sciences
American Smelting & Refining Co.

James L. Weeks
Industrial Hygienist
United Mineworkers of America

Roger H. Wingate
Executive Vice President (retired)
Liberty Mutual Insurance Co.

Agent Orange Study Protocol Review Advisory Panel

Richard Remington, *Chair*
Vice President for Academic Affairs
University of Iowa

Margit Bleecker
Assistant Professor
Division of Occupational Medicine
School of Hygiene and Public Health
The Johns Hopkins Medical Institutes

George L. Carlo
George Carlo & Associates

Neal Castagnoli, Jr.
Professor, Department of Chemistry and Pharmaceutical Chemistry
University of California, San Francisco

Theodore Colton
Professor
School of Public Health
Boston University

Frederic Halbert
Delton, MI

George B. Hutchison
Professor
School of Public Health
Harvard University

Patricia King
Professor
Georgetown Law Center

Lewis Kuller
Professor
Department of Epidemiology
Graduate School of Public Health
University of Pittsburgh

Claire O. Leonard
Assistant Professor
Department of Pediatrics
University of Utah and Primary Children's Medical Center

Robert O'Toole
Appeals Consultant
Veterans of Foreign Wars of the United States

John F. Sommer, Jr.
Assistant Director
National Veterans Affairs and Rehabilitation Commission
The American Legion

John F. Terzano
National Membership Director
Vietnam Veterans of America

Monte C. Throdahl
Senior Vice President
Environmental Policy Staff
Monsanto Co.

H. Michael D. Utidjian
Corporate Medical Director
American Cyanamid Co.

Blood Policy and Technology

Louanne Kennedy, *Chair*
Associate Professor
Department of Health Care Administration
Mt. Sinai School of Medicine

Alvin W. Drake
Professor of Systems Science and Electrical Engineering
Operations Research Center
Massachusetts Institute of Technology

Thomas C. Drees
President
Alpha Therapeutic Corp.

Tibor J. Greenwalt
Director
Paul I. Hoxworth Blood Center
University of Cincinnati Medical Center

Sylvia Drew Ivie
Director
National Health Law Program

Aaron Kellner
President
New York Blood Center

Sidney S. Lee
President
Milbank Memorial Fund

James W. Mosley
Acute Communicable Disease Control Section
Department of Health Services
Los Angeles County

Sharon Perkins
Coordinator, Donor Program
Fairfax Hospital, VA

Michael B. Rodell
Vice President
Regulatory and Technical Affairs
Ethical Products Division
Revlon Health Care Group

Rosemary Stevens
Professor
Department of History and Sociology of Science
University of Pennsylvania

Scott N. Swisher
President's Council
American Red Cross
National Headquarters

Martin J. Valaske
Medical Director
Medical Faculty Associates
George Washington University Medical Center

William D. White
Associate Professor
Department of Economics
University of Illinois, Chicago

Theodore Zimmerman
Professor, Department of Immunology
Department of Basic and Clinical Research
Scripps Clinic and Research Foundation

Wolf Zuelzer
Executive Director
National Hemophilia Foundation

Scientific Validity and Reliability of Polygraph Testing

Joseph P. Buckley
President
John E. Reid & Associates

Robert Edelberg
Professor of Psychiatry and Psychology
Rutgers Medical School

Frank Horvath
Associate Professor
School of Criminal Justice
Michigan State University

David T. Lykken
Professor of Psychiatry and Psychology
Department of Psychiatry
University of Minnesota Medical School

Martin T. Orne
Professor of Psychiatry
Director, Unit for Experimental Psychiatry
University of Pennsylvania Medical School

Gail J. Povar
Assistant Professor of Medicine and Health Care Sciences
The George Washington University Medical Center

Steve Pruitt
Director of Congressional Affairs
Public Employees Department
AFL-CIO

Christopher H. Pyle
Associate Professor of Politics
Mt. Holyoke College

David C. Raskin
Professor of Psychology
University of Utah

Harold Sigall
Professor of Psychology
University of Maryland

George B. Trubow
Professor
The John Marshall Law School

Althea M. I. Wagman
Research Associate of Psychiatry
Neuroscience Program
University of Maryland School of Medicine

Paul M. Wortman
Associate Professor of Public Health
Program Director, Institute for Social Research
University of Michigan

Status of Biomedical Research and Related Technology for Tropical Diseases Advisory Panel

Pedro Acha
Director of Programming and Operations Coordination
Pan American Health Organization

George Alleyne
Chief
Research Promotion and Coordination
Pan American Health Organization

Karen Bell
Professional Associate
Board on Science and Technology for International Development
National Academy of Sciences

William Campbell
Senior Director
Basic Parasitology
Merck, Sharpe, & Dohme

Richard Cash
Director
Office of International Health
Harvard School of Public Health

Barnett Cline
Professor and Chairman
Department of Tropical Medicine
Tulane Medical Center

Joseph Cook
Program Director
Tropical Disease Research
The Edna McConnell Clark Foundation

Robert Goodland
Ecologist
Office of Environmental Affairs
World Bank

Abraham Horowitz
Director Emeritus and Special Consultant
Pan American Health Organization

Dieter Koch-Weser
Chairman, Department of Preventive and Social Medicine
Harvard Medical School

Francisco Lopez-Antunano
Coordinator
Tropical Disease Programme
Pan American Health Organization

Arnold Monto
Professor, Department of Epidemiology
School of Public Health
University of Michigan

Ruth Nussenzweig
Division of Parasitology
New York University School of Medicine

Richard Riegelman
Associate Professor
Department of Health Care Sciences
The George Washington University Medical Center

Gabriel Schmunis
Medical Officer
Tropical Diseases Programme
Pan American Health Organization

Thomas Simpson
Director
Eastern Shore Health District
Accomack County Health Department

Ronald Vogel
Associate Professor
Department of Management and Policy
College of Business and Public Administration
University of Arizona

Kenneth Warren
Director of Health Sciences
The Rockefeller Foundation

Medical Technology and Diagnosis Related Groups: Evaluating Medicare's Prospective Payment System Advisory Panel

John Eisenberg, *Chair*
Associate Professor of Medicine
University of Pennsylvania

John R. Ball
Associate Executive Vice President for Health and Public Policy
American College of Physicians

Morris Collen
Consultant
Department of Medical Methods Research
Kaiser-Permanente Medical Program

Helen Darling
Director, Human Research Studies
Government Research Corp.

Judith Feder
Co-Director
Center for Health Policy Studies
Georgetown University

Susan B. Foote
Assistant Professor
School of Business Administration
University of California, Berkeley

Anthony Gigliotti
Executive Vice President
United Hospital, Inc.

Melvin Glasser
Director
Health Security Action Council

Henry Grabowski
Professor, Department of Economics
Duke University

Mark Hornbrook
Senior Investigator
Health Services Research Center
Kaiser-Permanente Health Care Program

Ronald Hurst
Manager, Health Care Planning
Caterpillar Tractor

Judith Lave
Professor, Department of Health Economics
University of Pittsburgh

Barbara J. McNeil
Professor, Department of Radiology
Harvard Medical School

Heather Palmer
Assistant Professor
Health Policy and Management
Harvard School of Public Health

William Rial
Consultant

Richard Riegelman
Associate Professor of Medicine and Health Care Sciences
George Washington University School of Medicine

Leonard Saxe
Associate Professor, Department of Psychology
Boston University

Stephen Shortell
Professor of Hospital and Health Services Management and Organization Behavior
J. L. Kellogg Graduate School of Management
Northwestern University

Donald Sutherland
Director
Clinical and Instrument Systems
E. I. du Pont de Nemours & Co.

Bruce Vladeck
President
United Hospital Fund of New York

John E. Wennberg
Professor, Department of Community and Family Medicine
Dartmouth Medical School

James Young
Vice President and Medical Director
Blue Cross/Blue Shield of Massachusetts

Workshop: Inpatient Classification System

Mark Hornbrook, *Chair*
Senior Investigator
Health Services Research Center
Kaiser-Permanente Health Care Program

Richard Averill
Vice Chairman
Health Systems International

Meryl Bloomrosen
Health Policy Analyst
Prospective Payment Assessment Commission

Joan Buchanan
Operations Researcher
Systems Sciences Department
The Rand Corp.

Paul Campbell
Research Manager
Health Industry Manufacturers Association

Rosanna Coffey
Director, Hospital Study Program
National Center for Health Services Research

Carlton Evans
Director
Allocation Development Service
Veterans Administration

Deborah Freund
Assistant Professor
School of Public Health
University of North Carolina, Chapel Hill

Paul Gertman
Chairman of the Board and Chief Specialist
Health Data Institute

Phyllis Giovannetti
Associate Professor
Faculty of Nursing
University of Alberta, Edmonton

Joseph Gonnella
Dean and Vice President
Jefferson Medical College

Susan D. Horn
Associate Director
The Center for Hospital Finance and Management
The Johns Hopkins Medical Institutions

Julian Pettengill
Specialist in Social Legislation
Congressional Research Service
Library of Congress

Douglas Wagner
Senior Research Specialist
ICU Research
George Washington University

Sankey V. Williams
Associate Professor
Hospital of the University of Pennsylvania

Patricia Willis
Senior Research Analyst
Health Care Financing Administration
U.S. Department of Health and Human Services

Wanda W. Young
Vice President
Health Care Research
Blue Cross of Western Pennsylvania

Prospective Payment Assessment Commission Review Panel

H. David Banta
Deputy Director
Pan American Health Organization

Kurt Deuschle
Professor of Community Medicine
Mount Sinai School of Medicine

Connie Evashwick
Director, Long-Term Care
Pacific Health Resources

Joanne Glisson
Assistant Director for Government Relations
Office of the Vice President for Public Affairs
Stanford University

Spencer Johnson
Executive Vice President
Hospital Association of New York State
Center for Health Initiatives

Sidney S. Lee
President
Milbank Memorial Fund

Frank Rhodes
President
Cornell University

Frederick C. Robbins
President
Institute of Medicine

Frank Samuel, Jr.
Partner
Dickstein, Shapiro & Morin

Kerr L. White
Consultant

Albert P. Williams
Director, Health Sciences Program
The Rand Corp.

Wanda Young
Vice President of Health Care Research
Blue Cross of Western Pennsylvania

Physicians and Medical Technology: Use, Cost, and Payment Methods Advisory Panel

John Ball
Associate Executive Vice President
American College of Physicians

Thomas Beauchamp
Professor of Philosophy and Senior Research Scholar
Kennedy Institute of Ethics
Georgetown University

Karen Davis
Chair, Department of Health Policy and Management
School of Hygiene and Public Health
Johns Hopkins University

Richard C. Dever
Fellow and Governor at Large for Florida
American College of Surgeons

Joseph Eichenholz
Assistant Vice President, CIGNA
Affiliated Businesses Group

Peter Fox
Vice President
Lewin & Associates

Jack Hadley
Co-Director
Center for Health Policy Studies
Georgetown University

Ronald E. Henderson
Consultant

Sidney Lee
President
Milbank Memorial Fund

Jack Meyer
Director for Health Policy Studies
American Enterprise Institute

Janet Mitchell
Vice President
Health Economics Research

Vita R. Ostrander
President
American Association of Retired Persons

Thomas Pyle
President and Chief Executive Officer
Harvard Community Health Plan

Uwe Reinhardt
Professor, Department of Economics
Princeton University

C. Burns Roehrig
President
American Society for Internal Medicine
New England Medical Center

Jerald Schenken
Vice Chairman, Council on Legislation
American Medical Association

Steven Schroeder
Professor of Medicine
University of California, San Francisco

Jack Shelton
Manager, Employee's Insurance Department
Ford Motor Co.

Robert H. Taylor
Executive Committee, Board of Directors
American Academy of Family Physicians

B. Elizabeth Tunney
Director, Legislation
Retail, Wholesale, and Department Store Union, International

Sankey Williams
Associate Professor
Section of General Medicine
Hospital of the University of Pennsylvania

Workshop: Use of Immunosuppressive Drugs in Kidney Transplantation

Jerome Aroesty
Senior Research Scientist
The Rand Corp.

Enrique D. Carter
Acting Director
Office of Health Technology Assessment
National Center for Health Services Research

Hinda Ripps Chaikind
Budget Analyst
Congressional Budget Office

Marianne Deignan
Budget Analyst
Congressional Budget Office

Roger W. Evans
Research Scientist
Battelle Human Affairs Research Centers

Robert D. Gordon
Attending Surgeon, Transplantation
Presbyterian-University Medical Center

Henry Krakauer
Special Assistant to Scientific Director
National Institute of Allergy and Infectious Diseases
National Institutes of Health

Calvin R. Stiller
Chief, Nephrology and Transplantation
University Hospital, Ontario

Charles T. Van Buren
Associate Professor of Surgery
University of Texas Medical School

David L. Winter
Director, Medical Research
Sandoz Inc.

SCIENCE, INFORMATION, AND NATURAL RESOURCES DIVISION

Communication and Information Technologies Program

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Center for Advanced Studies in the Behavioral Sciences

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Department of Computer Science
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Systems Planning Division
INTELSAT

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Thomas J. Watson Research Center
IBM Corp.

John V. Harrington
Director
COMSAT Laboratories

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Executive Vice President
David Sarnoff Research Center
RCA Corp.

Bruce Lusignan
Director
Communication Satellite Planning Center
Stanford University

Donald McCoy
Vice President and General Manager
CBS Technology Center

Ithiel de Sola Pool
Professor of Political Science
Massachusetts Institute of Technology

Paul E. Ritt, Jr.
Vice President and Director of Research
GTE Laboratories, Inc.

Larry W. Sumney
Executive Director
Semiconductor Research Cooperative

Victor Vyssotsky
Executive Director
Research, Information Sciences
Bell Telephone Laboratories

Robert E. Wesslund
Vice President for Technology Exchange
Control Data Corp.

George R. White
Senior Research Fellow
The Harvard Business School

Workshop: Software Engineering

Richard A. DeMillo
Information and Computer Science Department
Georgia Institute of Technology

George Dodd
Department Head
Computer Science Department
General Motors Research Laboratories

Capers Jones
Manager of Programming and Technology Analysis
ITT Corp.

Brian Kernighan
Head, Computing Structures Research
Bell Laboratories

Ann Marmor-Squires
Chief Technologist
TRW Defense Systems Group

Robert Mathis
Director
ADA Joint Program Office

Harlan Mills
IBM Fellow
IBM Corp.

Leon J. Osterweil
Chairman
Computer Science Department
University of Colorado, Boulder

C. V. Ramamoorthy
Department of Electrical Engineering and Computer Science
University of California, Berkeley

Paul Schneck
Leader, Information Sciences Division
Office of Naval Research

Ben Schneiderman
Department of Computer Science
University of Maryland

Steve Squires
Software Technology Programming Manager
DARPA/IPTO

Terry A. Straeter
Vice President and Program Director
General Dynamics Electronics

Raymond Yeh
Professor
Computer Science Department
University of Maryland, College Park

The Effects of Information Technology on Financial Services Systems Advisory Panel

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Holer Professor of Management
The Wharton School
University of Pennsylvania

Donald I. Baker
Partner
Sutherland, Asbill & Brennan

Paul Baran
Vice President—Engineering
PacketCable

Lynne Barr, Esq.
Gaston-Snow & Ely Bartlett

Robert Capone
Vice President and Director
Systems & Data Processing
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Kent Colton
Executive Vice-President
National Association of Homebuilders

Richard J. Darwin
Manager
Financial Industry Systems Group
Battelle Memorial Institute

Gerald Ely
Director
Information Systems Division
Merrill Lynch Capital Market

John Farnsworth
Senior Vice President
Bank of America

Paul Hefner
Vice President
First Interstate Bancard

Edward J. Kane
The Everett D. Reese Professor of Banking in Monetary Economics
Department of Economics
Ohio State University

Jerome Svigals
IBM Financial Services Industry Marketing
IBM Corp.

Willis H. Ware
Senior Computer Specialist
The Rand Corp.

Steven Weinstein
Vice President—Corporate Strategy
American Express

Milton Wessel
Legal Counsel
Association of Data Processing Service Organizations

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Vice President
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Institute for the Future

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Former Director
Engineering Computing Systems
Boeing Commercial Airplane Co.

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Vice President
Technical Personnel Development
IBM Corp.

Barbara A. Burns
Manufacturing Technical Group Engineer
Lockheed-Georgia

Jack Cahall
Manager, Training and Development
Cincinnati Milacron, Inc.

Dennis Chamot
Assistant Director
Department for Professional Employees
AFL-CIO

Robert Cole
Director
Center for Japanese Studies
University of Michigan

*Now Director, National Science Foundation

Alan E. Drane
Manager of Automated Systems
Emhart Corp.

Audrey Freedman
Senior Research Associate
The Conference Board, Inc.

Sheldon Friedman
Director, Research Department
United Aerospace and Agricultural Implement Workers of America, UAW

Theodore W. Kheel
Office Counsel
Battle, Fowler, Jaffin & Kheel

James F. Lardner
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Manufacturing Development
Deere & Co.

Eli Lustgarten
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Paine Webber Mitchell Hutchins, Inc.

M. Granger Morgan
Professor
Engineering and Public Policy
Carnegie-Mellon University

George J. Poulin
General Vice President
International Association of Machinists and Aerospace Workers

Bernard M. Sallot
Director, Professional and Governmental Activities
Society of Manufacturing Engineers
Executive Director
Robot Institute of America

Harley Shaiken
Research Fellow
Massachusetts Institute of Technology

Kevin G. Snell
Director, Forward Planning Program and Development
Career Works, Inc.

Alfred P. Taylor
Manager, Factory Automation Plant Services Operation
General Electric Co.

Philippe Villers
President
Automatix, Inc.

Victor C. Walling, Jr.
Coordinator
Business Futures Program
SRI International

Dennis Wisnosky
Vice President
Industrial Systems Group
GCA Corp.

Michael J. Wozny
Director
Center for Interactive Computer Graphics
Rensselaer Polytechnic Institute

Robert Zager
Vice President, Policy Studies and Technical Assistance
Work in America Institute

Federal Government Information Technology: Administrative Process and Civil Liberties Advisory Panel

Theodore J. Lowi, *Chair*
John L. Senior Professor of American Institutions
Cornell University

Arthur G. Anderson
Vice President
IBM Corp.

Jerry J. Berman
Legislative Counsel
American Civil Liberties Union

R. J. Bogumil
President
IEEE Society on Social Implications of Technology

James W. Carey
Dean, College of Communications
University of Illinois, Urbana

Robert L. Chartrand
Senior Specialist
Congressional Research Service
Library of Congress

Melvin Day
Vice President
Research Publications

Joseph Duncan
Corporate Economist
The Dun & Bradstreet Corp.

William Dutton
Associate Professor of Communications and Public Administration
Annenberg School of Communications
University of Southern California

David H. Flaherty
Professor of History and Law
Privacy Project
University of Western Ontario

Carl Hammer
Consultant

Robert D. Harris
Deputy Assistant Director for Budget Analysis
Congressional Budget Office

Dale N. Hatfield
Dale N. Hatfield Associates

Starr Roxanne Hiltz
Professor of Sociology
Upsala College

Kenneth W. Hunter
Senior Associate Director
Accounting and Financial Management Division
U.S. General Accounting Office

John C. Lautsch
Attorney at Law

Edward F. Madigan
Data Processing Consultant
Data Processing Division
Oklahoma Department of Transportation

Marilyn Gell Mason
Director
Atlanta Public Library

Joe Skinner
Corporate Vice President
Electronic Data Systems Corp.

Terril J. Steichen
President
New Perspective Group, Ltd.

George Trubow
Director, Center for Information Technology and Privacy Law
The John Marshall Law School

Susan Welch
Professor and Chairperson of Political Science Department
University of Nebraska, Lincoln

Alan F. Westin
Professor of Public Law and Government
Columbia University

Langdon Winner
Associate Professor of Politics
Crown College
University of California, Santa Cruz

Intellectual Property Rights in an Age of Electronics and Information
Advisory Panel

Paul Goldstein, *Chair*
Professor of Law
Stanford University

Jon A. Baumgarten
Partner
Paskus, Gordon & Hyman

Charles Benton
President of the Board
Benton Foundation
Chairman, Public Media Inc.

Stanley Besen
Economist
The Rand Corp.

Stephen Breyer
Judge
U.S. Court of Appeals

Harlan Cleveland
Director, Hubert Humphrey Institute of Public Affairs
University of Minnesota, Minneapolis

Stan Cornyn
Senior Vice President
Warner Brother Records

Oswald H. Ganley
Professor and Executive Director
Program on Information Resources Policy
Harvard University

Paul Goldstein
Professor of Law
Stanford University

Gustave M. Hauser
Chairman and Chief Executive Officer
Hauser Communications, Inc.

Mitchell Kapor
President
Lotus Corp.

Robert Lekachman
Professor of Economics
Lehman College

William Lilley, III
Vice President for Corporate Affairs
CBS

George Minot
Senior Vice President
Compuserve, Inc.

Dorothy Nelkin
Professor of Sociology
Cornell University

James A. Nelson
State Librarian and Commissioner
Kentucky Department of Libraries and Archives

John Shattuck
Vice President for Government and Public Affairs
Harvard University

Ollie Smoot
Executive Vice President
Computer and Business Equipment Manufacturers Association

Patricia Sturdivant
Associate Superintendent
Houston Independent School District

Sherry Turkle
Associate Professor of Sociology
Massachusetts Institute of Technology

Jack Valenti
President
Motion Picture Association of America Inc.

Vivian Weil
Senior Research Associate
Illinois Institute of Technology

Martha Williams
Professor of Information Science
University of Illinois

Workshop: Information Planning

Mary Gardiner Jones
Consultant

Rob Kling
Department of Computer Science
University of California, Irvine

Susan Nycum
Gaston Snow & Ely Bartlett

John Palmer
Director
Center for Economic Analysis of Property Rights
The University of Western Ontario

John Shattuck
Vice President for Government Community and Public Affairs
Harvard University

Joe Stiglitz
Department of Economics
Princeton University

George Trubow
John Marshall Law School

Willis Ware
Corporate Research Staff
The Rand Corp.

Milton Wessel
Consultant

Alan Westin
Department of Political Science
Columbia University

Joseph Wyatt
Chancellor
Vanderbilt University

Workshop: Legal Problems in Intellectual Property

Andrew Arno
Professor of Law
University of Hawaii

Jon A. Baumgarten
Partner
Paskus, Gordon & Hyman

Jerry Berman
Legislative Counsel
American Civil Liberties Union

Roy Freed
Partner
Brown, Rudnick, Freed & Gesmer, Counsellors at Law

Leon Friedman
Attorney-at-Law

Morton Goldberg
Partner
Schwab, Goldberg, Price & Dannay

Paul Goldstein
Professor at Law
Stanford Law School

Henry W. Jones, III
General Counsel
Ashton-Tate

Irwin Karp
General Counsel
Authors League

Mike Keplinger
Attorney Advisor
Office of Legislative and International Affairs
U.S. Patent and Trademark Office

John Lautsch
Chairman
ABA Computer Law Division

Arthur Levine
Partner
Levine, Lupo & Lippman

Nancy Marshall
Chairperson of Copyright Committee
American Library Association

Christopher Meyer
Senior Attorney
Copyright Office
Library of Congress

Melville Nimmer
Professor of Law
UCLA Law School

Ron Palenski
Staff Attorney
The Association of Data Processing Service Organizations

Marybeth Peters
Senior Attorney
Copyright Office
Library of Congress

Mary Hutchins Reed
Attorney
American Library Association

Carol Rischer
Counsel
Association of American Publishers

Mark Rotenburg
President
Public Interest Computer Association

Pamela Samuelson
Professor of Law
University of Pittsburgh

Cary Sherman
Attorney-at-Law
Arnold & Porter

Eric Smith
Partner
Paskus, Gordon & Hyman

Ray Weisbond
Corporate Attorney
Warner Communications

Information and Communication Technologies and the Office Advisory Panel

Henry C. Lucas, *Chair*
Chairman, Department of Computer Applications and Information Systems
Graduate School of Business
New York University

Charles B. Branscomb
Vice President, Telecommunications
Communication Products Division
IBM Corp.

Dennis Chamot
Assistant Director
Department of Professional Employees
AFL-CIO

Roger R. Collins
Director
Integrated Office Systems Training
Northern Telecom Inc.

Marvin Dainoff
Professor of Psychology
Miami University

Rosalyn L. Feldberg
Visiting Research Scholar
Henry A. Murray Research Center
Radcliffe College

Thomas G. Hermann
Chairman, Law Office Technology Committee
American Bar Association

Robert C. Hughes
Vice President and Group Manager
Business and Office Systems Marketing
Digital Equipment Corp.

Barbara B. Hutchison
Director, Women's Division
American Federation of Government Employees

Lois Martin
Vice President
The First National Bank of St. Paul

Vernell K. Munson
Manager, Advanced Systems Laboratory
Wang Laboratories, Inc.

Karen Nussbaum
Executive Director
9 to 5: National Association of Working Women

Robert M. Peabody
Assistant Vice President and Director of Office Automation
Mutual of Omaha

Randy J. Pilc
Department Head
Product Family Services
AT&T Information Services

Robert Ellis Smith
Editor and Owner
Privacy Journal

Ralph E. Upton, Jr.
Director
St. Augustine Technical Center

Workshop: Federal Depository Libraries

Brian Aveney
Director of Research and Development
Blackwell North America

Henriette Avram
Assistant Librarian for Processing Services
Library of Congress

Richard W. Boss
Senior Consultant
Information Systems Consultants Inc.

Joe Ford
Executive Director
CAPCON

F. W. Lancaster
Professor
Graduate School of Library and Information Science
University of Illinois, Urbana

Judy McQueen
Consultant
Information Systems Consultants Inc.

Peter Preksto
Vice President
INTRAN

Patricia Glass Schuman
President
Neal-Schuman Publishers, Inc.

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Gary Arlen
President
Arlen Communications

Jesse Filkins
Senior Attorney
Division of Consumer and Community Affairs
Board of Governors of the Federal Reserve System

John Fisher
Senior Vice President
Banc One Corp.

Eric Lee
Legislative Director
Office of Senator Inouye
United States Senate

Nancy Miller
Analyst
Science Policy Research Division
Congressional Research Service
Library of Congress

George Minot
Senior Vice President
CompuServe, Inc.

William Seelinger
Manager, Videotex Market Development
IBM Corp.

Bettie Steiger
Vice President of Information Resources
Reference Technology

Joe D. Wetherington
President
Global Information Strategies Inc.

Workshop: Postal Automation

Nicholas Barranca
General Manager
In-Plant Operations Division
U.S. Postal Service

Robert Buzard
President
ElectroCom Automation Inc.

Robert Cohen
Director of Technical Analysis and Planning
Postal Rate Commission

Larry S. Davis
Head, Computer Vision Laboratory
Center for Automation Research
University of Maryland, College Park

Warren Denise
Director, Office of Mechanization and Facility Development
U.S. Postal Service

Willis Elmore
Group Director
U.S. Postal Service Audit Site

William Gingras
President
Friendship Engineering Co.

Harold Glass
Manager
Electronic Design Development Branch
Maintenance Division
U.S. Postal Service

Dana Grubb
Electronic Engineer
National Bureau of Standards
Department of Commerce

Robert Hadley
Evaluator
U.S. General Accounting Office

Art Hamburgen
Senior Technical Staff
Storage Products Division
IBM Corp.

James V. Jellison
Senior Assistant Postmaster General
Operations Group
U.S. Postal Service

Lynn A. Kidd
General Manager
Analytical Support Division
U.S. Postal Service

Jerry Loftus
Group Vice President
Engineering and Planning
The Business Equipment Group
Bell & Howell

Walter Marable
Executive Director
Engineering Support Center
U.S. Postal Service

Aldo Mazzoni
President
ELSAG, Inc. (U.S.)

Ray Morgan
Manager
Equipment Development Branch
U.S. Postal Service

Jeryle Mumpower
Program Manager
Division of Policy Research and Analysis
National Science Foundation

Robert P. Otten
Deputy Director
Distribution Department
The Reader's Digest

James E. Pehta
Executive Vice President
List Processing Co.

Robert E. Price
Senior Evaluator
U.S. Postal Service Audit Site

Jacob Rabinow
Chief Research Engineer
National Engineering Laboratory
National Bureau of Standards

Herbert S. Schantz
Vice President
Graham Magnetics, Inc.

Israel Sheinberg
Group Vice President
Recognition Equipment, Inc.

Dick Stotler
Acting General Manager
Automation Systems Division
System Development Corp. (Burroughs)

Robert Tracy
Director of Engineering
Pitney Bowes

Jacob W. Ulvila
Vice President
Decision Science Consortium, Inc.

Thomas W. Unger
Manager, Credit Card Systems
Shell Oil Co.

Oceans and Environment Program

Managing High-Level Commercial Radioactive Waste Advisory Panel

Hans Frauenfelder, *Chair*
Professor, Department of Physics
University of Illinois

Seymour Abrahamson
Professor, Department of Zoology
University of Wisconsin

Frank Collins
Consultant

Floyd Culler
President
Electric Power Research Institute

J. William Futrell
President
Environmental Law Institute

Edward Goldberg
Professor of Geology
Scripps Institution of Oceanography
University of California

Harriet Keyserling
Member
House of Representatives
State of South Carolina

Terry Lash
Deputy Director
Department of Nuclear Safety
State of Illinois

Jeanne Malchon
President
Candorcom Corp.

Glenn Paulson
Vice President for Science
National Audubon Society

Howard Raiffa
Frank P. Ramsey Professor of Managerial Economics
Harvard Business School

William A. Thomas
Consultant
American Bar Foundation

Mason Willrich
Vice President—Corporate Planning
Pacific Gas & Electric Co.

Donald Wodrich
Rockwell International-Hanford Operations

John Yasinsky
General Manager
Advanced Power Systems Divisions
Westinghouse Electric Corp.

Acid Rain and Transported Air Pollutants Advisory Panel

Norton Nelson, *Chair*
Professor
Department of Environmental Medicine
New York University Medical Center

Thomas H. Brand
Director, Environmental Activities
Edison Electric Institute

Robert Wilbur Brocksen
Manager—Ecological Effects Program
Electric Power Research Institute

Jack George Calvert
Senior Scientist
National Center for Atmospheric Research

David Hawkins
Senior Attorney
National Resources Defense Council, Inc.

Edward A. Helme
Staff Director
Committee on Energy and Environment
National Governor's Association

Richard L. Kerch
Manager, Air Quality
Consolidation Coal

Anne LaBastille
Commissioner
Adirondack Park Agency

Gene E. Likens
Professor of Ecology
Section of Ecology and Systematics
Cornell University

Donald H. Pack
Consultant

Carl Shy
Professor of Epidemiology
School of Public Health
University of North Carolina

Lester Thurow
Professor of Management and Economics
Sloan School of Management
Massachusetts Institute of Technology

George H. Tomlinson, II
Vice President
Domtar Inc.

Wetlands: Their Use and Regulation Advisory Panel

William H. Patrick, Jr., *Chair*
Director, Laboratory for Wetland Soils and Sediment
Louisiana State University

Hope M. Babcock
Director
Public Lands and Public Water
National Audubon Society

Earl H. Beistline
Fairbanks, Alaska
(Ex Officio Panel Member)

Charles E. Fraser
President
Sea Pines Co.

Donald E. Gilman
Alaska State Senator

Laurence R. Jahn
Vice President
Wildlife Management Institute

Joseph S. Larson
Chairman, Department of Forestry and Wildlife Management
University of Massachusetts

Stanley L. Lattin
Director of Planning and Economic Development
Port of Grays Harbor

Jay A. Leitch
Professor
Department of Agricultural Economics
North Dakota State University

Ralph Manna, Jr.
Division of Regulatory Affairs
Department of Environmental Conservation
State of New York

William Manning
Manager
Safety and Environmental Affairs
Louisiana Land & Exploration Co.

Eric Metz
Wetland Program Manager
California Coastal Commission

Mark Rey
Director, Water Quality Programs
National Forest Products Association

Laurence Simns
President
Maryland Waterman's Association

Hobart G. Truesdell, II
President, First Colony Farms

Daniel E. Willard
Professor of Public and Environmental Affairs
Indiana University

Assessment of Maritime Trade and Technology Advisory Panel

Leslie Kanuk, *Chair*
Professor of Marketing
Baruch College

Vera Alexander
Director, Division of Marine Science
University of Alaska

Richard F. Brunner
Senior Operating Officer
Avondale Shipyards, Inc.

Paul J. Burnsky
President
Metal Trades Department
AFL/CIO

H. Clayton Cook, Jr.
Partner
Cadwalader, Wickersham, & Taft

J. P. Elverdin
President
Navios Corp.

Peter J. Finnerty
Vice President for Public Affairs
Sea-Land Industries

Jack Goldstein
Vice President and Economist
Overseas Shipholding Group, Inc.

R. J. Lowen
President
Masters, Mates & Pilots of America

C. M. Lynch
President
ARCO Marine Inc.

David L. Pearson
Chief of Engineering
Electric Boat Division
General Dynamics Corp.

Eugene K. Pentimonti
Vice President, Engineering
American President Lines, Ltd.

Paul F. Richardson
Paul F. Richardson Associates, Inc.

John P. Scally
Manager of Export Transportation
General Electric Co.

Lawrence A. Smith
President
Lockheed Shipbuilding Co.

Protecting the Nation's Groundwater From Contamination Advisory Panel

Thomas Maddock III, *Chair*
Department of Hydrology and Water Resources
University of Arizona

Harvey Banks
Consulting Engineers, Inc.

Robert Harris
Professor
Center for Energy and Environmental Studies
Princeton University

Allen V. Kneese
Senior Fellow
Resources for the Future

Jay H. Lehr
Executive Director
National Well Water Association

Perry McCarty
Chairman
Department of Civil Engineering
Stanford University

James Mercer
President
GeoTrans, Inc.

David W. Miller
President
Geraghty & Miller, Inc.

Michale A. Pierle
Director
Regulatory Management—Water
Monsanto Co.

Lawrence Swanson
Director
Great Plains Office of Policy Studies
University of Nebraska

James T. B. Tripp
Counsel
Environmental Defense Fund

Technology for Developing Offshore Oil and Gas Resources in Hostile Environments Advisory Panel

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Director
Woods Hole Oceanographic Institute

Jacob Adams
President
Arctic Slope Regional Corp.

Lawrence N. Bell
Vice President
Arco Oil & Gas Co.

Charles L. Blackburn
Executive Vice President
Exploration and Development
Shell Oil Co.

Sarah Chasis
Senior Staff Attorney
Natural Resources Defense Council

Clifton E. Curtis
Executive Vice President
The Oceanic Society

Gordon Duffy
Secretary, Environmental Affairs
State of California

Walter R. Eckelmann
Senior Vice President
Sohio Petroleum Corp.

William Fisher
State Geologist
State of Texas

Robert Grogan
Associate Director for Governmental Coordination
Office of the Governor of Alaska

Frank J. Iarossi
President
Exxon Shipping Co.

Don E. Kash
Director
Science and Public Policy Program
University of Oklahoma

Dan R. Motyka
Vice President—Frontier
Gulf Canada Resources, Inc.

C. Robert Palmer
Board Chairman and President
Rowan Companies, Inc.

Stanley Stiansen
Vice President
American Bureau of Shipping

Wallace Tyner
Department of Agricultural Economics
Purdue University

Michael T. Welch
Vice President
Citibank, N.A.

Technologies for Disposing of Waste in the Ocean Advisory Panel

Thomas Clingan, *Chair*
School of Law
University of Miami

Walter Barber
Vice President for Environmental Compliance
Waste Management, Inc.

William Bascom
Director
Southern California Coastal Water Research Project

Rita Colwell
Vice President for Academic Affairs
University of Maryland, College Park

A. Myrick Freeman III
Department of Economics
Bowdoin College

John Gosdin
Director of Natural Resources
Governor's Office, Texas

Zeke Grader
General Manager and Counsel
Pacific Coast Federation of Fishermen's Associations

John Hinck
National Toxics Coordinator
Greenpeace

Robert Hope
Director, Port of Mobile
Alabama State Docks Department

Kenneth Kamlet
Director, Pollution and Toxic Substances Division
National Wildlife Federation

John A. Knauss
Vice President, Marine Program
Graduate School of Oceanography
University of Rhode Island

William J. Marrazzo
Water Commissioner
City of Philadelphia

Joseph T. McGough, Jr.
Commissioner
New York City Department of Environmental Protection

Mike Norton
First Secretary (Science)
British Embassy

Jerry Schubel
Director
Marine Sciences Research Center
State University of New York at Stony Brook

Richard F. Schwer
Environmental Consultant
Dupont Engineering Department

Science, Transportation, and Innovation Program

Civilian Space Stations Advisory Panel

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Cabot Corp.

Harvey Brooks
Benjamin Peirce Professor of Technology and Public Policy
Harvard University

Peter O. Crisp
President
Venrock, Inc.

Freeman Dyson
Professor
Institute for Advanced Study
Princeton University

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Booz Allen & Hamilton, Inc.

Charles E. Fraser
Chairman
Sea Pines Co.

Andrew J. Goodpaster
President
Institute of Defense Analyses

Charles Hitch
The Lawrence-Berkeley Laboratory
University of California, Berkeley

Bernard M. W. Knox
Director
Center for Hellenic Studies

Moya Lear
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Lear Avia Corp.

George E. Mueller, Jr. (retired)
President and Chief Executive Officer
System Development Corp.

Carl Sagan
Director of the Laboratories for Planetary Studies
Cornell University

Eugene Skolnikoff
Director
Center for International Studies
Massachusetts Institute of Technology

James Spilker
President
Stanford Telecommunications Inc.

Frank Stanton
President Emeritus
CBS Inc.

James A. Van Allen
Head
Physics and Astronomy Department
University of Iowa

Workshop: Unit Cost

James Albus
Chief of Industrial Systems Division
National Bureau of Standards

William D. Bumgarner
Senior Member of the Executive Staff
Computer Sciences Corp.

Esker K. Davis
Pickering Research Corp.

James Graham
Senior Research Associate
John Deere & Co. Technical Center

Jack Harrington
Senior Vice President
Research and Development
COMSAT Laboratory

Walter Kapryan
Director and Senior Technical Advisor
Lockheed Corp.

Donald H. Novak
Project Manager
Computer Sciences Corp.

William Perkins
Director, Strategic Business Management
Rockwell International

William C. Schneider
Vice President
Control Systems Activity
Computer Sciences Corp.

Donald K. Slayton
President
Space Services, Inc.

William C. Stone
Research Structural Engineer
National Bureau of Standards

David Wensley
Chief Program Engineer
Space Stations
McDonnell Douglas Astronautics Co.

James E. Wilson
Consultant

Workshop: Automation and Space

David Akin
Professor, Department of Aeronautics and Astronautics
Massachusetts Institute of Technology

James Albus
Chief of Industrial Systems Division
National Bureau of Standards

Michael Arbib
Professor
Department of Computer and Information Science
University of Massachusetts, Amherst

Ruzena Bajcsy
Professor, Department of Computer and Information Sciences
Moore School of Electrical Engineering
University of Pennsylvania

Michael Brady
Professor
Artificial Intelligence Laboratory
Massachusetts Institute of Technology

Rodney Brooks
Professor
Department of Computer Sciences
Stanford University

Margaret Eastwood
Vice President of Engineering
GCA Corp.

Charles Fraser
Chairman
Sea Pines Co.

William Isler
Program Manager
Systems Science Division
Defense Advanced Research Projects Agency

Steven Jacobson
Professor
Department of Mechanical Engineering
University of Utah

Henry Lum
Acting Manager
Office of Computer Science and Electronics
National Aeronautics and Space Administration

David Nitzan
Director, Robotics Department
SRI International

Marc Raibert
Professor, Department of Computer Science
Carnegie-Mellon University

Carl Ruoff
Member of Staff
Jet Propulsion Laboratory

Roger Schapell
Manager, Advanced Automation Technology
Denver Aerospace
Martin Marietta Corp.

Thomas Sheridan
Professor
Department of Mechanical Engineering
Massachusetts Institute of Technology

Russell Taylor
Manager of Robot System Technology
T. J. Watson Research Center
IBM Corp.

James A. Van Allen
Chairman, Department of Physics
University of Iowa

Workshop: Renewing U.S./U.S.S.R. Cooperation in Space: Problems and Prospects

Bernard Burke
William A. M. Burden Professor of Astrophysics
Department of Physics
Massachusetts Institute of Technology

Donald DeVincenzi
Chief, Biological Research Branch
Life Sciences Division
NASA Headquarters

Thomas M. Donahue
Professor
Department of Atmospheric and Oceanic Sciences
University of Michigan

Paul Gorenstein
Astrophysicist
Smithsonian Astrophysical Observatory

James W. Head
Professor
Department of Geological Sciences
Brown University

Martin Israel
Associate Director
McDonnell Center for the Space Sciences
Washington University at St. Louis

Charles Kennell
Chairman of the Department of Physics
University of California, Los Angeles

Eugene Levy
Director of the Lunar Planetary Lab
University of Arizona

Harold Masursky
Senior Scientist
U.S. Geological Survey

David Morrison
Vice Chancellor for Research
University of Hawaii

Tobias Owen
Professor of Astronomy
Earth and Space Sciences Department
State University of New York at Stony Brook

Fred Scarf
Chief Scientist
Space & Technology Group
TRW

Gerald Wasserburg
John D. MacArthur Professor of Planetary Sciences
California Institute of Technology

Airport System Development Advisory Panel

Don E. Kash, *Chair*
Director
Science and Public Policy Program
University of Oklahoma

James H. Anderson
Director, Office Buildings Division
General Services Department
E. I. du Pont de Nemours & Co.

Joseph Blatt
Consultant

Clifford W. Carpenter
Manager, Airport Development
Boeing Commercial Aircraft Co.

Pierre Champagne
Director of Airport Planning
Transport Canada

H. McKinley Conway
President
Conway Publications

Charilyn Cowan
Staff Director, Committee on Transportation, Commerce and Technology
National Governors' Association

Thomas J. Deane
Vice President, Operating Facilities
Avis Rent-A-Car, Inc.

John Drake
Professor of Air Transportation
School of Aeronautics and Astronautics
Purdue University

William Garrison
Professor
Institute of Transportation Studies
University of California, Berkeley

Aaron Gellman
President
Gellman Research Associates, Inc.

John Glover
Supervisor, Transportation Planning
Port of Oakland, CA

Leonard Griggs
Airport Director
Lambert St. Louis International Airport

Richard L. Harris
Vice President, Public Finance
First Boston Corp.

John Hoyt
Principal Project Manager
Ralph M. Parsons Co.

Jack R. Hunt
President
Embry-Riddle Aeronautical University

Richard Judy
Director of Aviation
Dade County, FL

Alfred Kahn
Alfred E. Kahn Associates, Inc.

Leonard Martin
Vice President, Passenger Services
Piedmont Airlines

Dorn McGrath
Chairman, Department of Urban and Regional Planning
The George Washington University

Sonny Najera
Director, Division of Aeronautics
State of Arizona

Edmund Nelle, Jr.
President
Butler Aviation International

Jan Roskam
Ackers Distinguished Professor of Aerospace Engineering
University of Kansas

William Supak
Aviation Director
Port of Portland, OR

William Wilson
Vice President, Properties and Facilities
Federal Express Corp.

Technology, Innovation, and Regional Economic Development Advisory Panel

William C. Norris, *Chair*
Chairman and Chief Executive Officer
Control Data Corp.

William J. Abernathy*
Professor
Graduate School of Business
Harvard University

William F. Aikman
President
Massachusetts Technology Development Corp.

Henry Cisneros
Mayor, City of San Antonio, Texas

Ella Francis
President
Parkside Association of Philadelphia

Aaron Gellman
President
Gellman Research Associates, Inc.

Don Lee Gevirtz
Chairman
The Foothill Group, Inc.

George W. Haigh
President and Chief Executive Officer
The Toledo Trust Co.

Quentin Lindsey
Science and Public Policy Advisor
Office of the Governor
State of North Carolina

Neal R. Pierce
Contributing Editor
National Journal

*Deceased.

David V. Ragone
President
Case Western Reserve University

J. David Roessner
Professor
Technology and Science Policy Program
Georgia Institute of Technology

John Stewart
Assistant General Manager
Tennessee Valley Authority

Ellen Sulzberger Straus
President
WMCA Radio

Alexander B. Trowbridge
President
National Association of Manufacturers

Thomas L. Yount, Jr.
Commissioner of Employment Security
State of Tennessee

Workshop: Standardized Testing

Eva Baker
Director, Human Evaluation Center
University of California, Los Angeles

Gray Garwood
Legislative Assistant
The Office of The Honorable Pat Williams
U.S. House of Representatives

George Madaus
Consultant

Deborah Stipek
The Office of The Honorable Bill Bradley
United States Senate

William W. Turnbull
Distinguished Scholar in Residence
Educational Testing Service

Alexandra Wigdor
Former Study Director
Committee on Ability Testing
National Academy of Science

Appendix C
OTA Act

Public Law 92-484
92nd Congress, H. R. 10243
October 13, 1972

An Act

To establish an Office of Technology Assessment for the Congress as an aid in the identification and consideration of existing and probable impacts of technological application; to amend the National Science Foundation Act of 1950; and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Technology Assessment Act of 1972". Technology Assessment Act of 1972.

FINDINGS AND DECLARATION OF PURPOSE

SEC. 2. The Congress hereby finds and declares that:

(a) As technology continues to change and expand rapidly, its applications are—

(1) large and growing in scale; and

(2) increasingly extensive, pervasive, and critical in their impact, beneficial and adverse, on the natural and social environment.

(b) Therefore, it is essential that, to the fullest extent possible, the consequences of technological applications be anticipated, understood, and considered in determination of public policy on existing and emerging national problems.

(c) The Congress further finds that:

(1) the Federal agencies presently responsible directly to the Congress are not designed to provide the legislative branch with adequate and timely information, independently developed, relating to the potential impact of technological applications, and

(2) the present mechanisms of the Congress do not and are not designed to provide the legislative branch with such information.

(d) Accordingly, it is necessary for the Congress to—

(1) equip itself with new and effective means for securing competent, unbiased information concerning the physical, biological, economic, social, and political effects of such applications; and

(2) utilize this information, whenever appropriate, as one factor in the legislative assessment of matters pending before the Congress, particularly in those instances where the Federal Government may be called upon to consider support for, or management or regulation of, technological applications.

ESTABLISHMENT OF THE OFFICE OF TECHNOLOGY ASSESSMENT

SEC. 3. (a) In accordance with the findings and declaration of purpose in section 2, there is hereby created the Office of Technology Assessment (hereinafter referred to as the "Office") which shall be within and responsible to the legislative branch of the Government.

(b) The Office shall consist of a Technology Assessment Board (hereinafter referred to as the "Board") which shall formulate and promulgate the policies of the Office, and a Director who shall carry out such policies and administer the operations of the Office. Technology Assessment Board.

(c) The basic function of the Office shall be to provide early indications of the probable beneficial and adverse impacts of the applications of technology and to develop other coordinate information which may assist the Congress. In carrying out such function, the Office shall: Duties.

(1) identify existing or probable impacts of technology or technological programs;

(2) where possible, ascertain cause-and-effect relationships;

(3) identify alternative technological methods of implementing specific programs;

(4) identify alternative programs for achieving requisite goals;

(5) make estimates and comparisons of the impacts of alternative methods and programs;

(6) present findings of completed analyses to the appropriate legislative authorities;

(7) identify areas where additional research or data collection is required to provide adequate support for the assessments and estimates described in paragraph (1) through (5) of this subsection; and

(8) undertake such additional associated activities as the appropriate authorities specified under subsection (d) may direct.

(d) Assessment activities undertaken by the Office may be initiated upon the request of:

(1) the chairman of any standing, special, or select committee of either House of the Congress, or of any joint committee of the Congress, acting for himself or at the request of the ranking minority member or a majority of the committee members;

(2) the Board; or

(3) the Director, in consultation with the Board.

Information, availability.

(e) Assessments made by the Office, including information, surveys, studies, reports, and findings related thereto, shall be made available to the initiating committee or other appropriate committees of the Congress. In addition, any such information, surveys, studies, reports, and findings produced by the Office may be made available to the public except where—

(1) to do so would violate security statutes; or

(2) the Board considers it necessary or advisable to withhold such information in accordance with one or more of the numbered paragraphs in section 552(b) of title 5, United States Code.

81 Stat. 54.

TECHNOLOGY ASSESSMENT BOARD

Membership.

SEC. 4. (a) The Board shall consist of thirteen members as follows:

(1) six Members of the Senate, appointed by the President pro tempore of the Senate, three from the majority party and three from the minority party;

(2) six Members of the House of Representatives appointed by the Speaker of the House of Representatives, three from the majority party and three from the minority party; and

(3) the Director, who shall not be a voting member.

Vacancies.

(b) Vacancies in the membership of the Board shall not affect the power of the remaining members to execute the functions of the Board and shall be filled in the same manner as in the case of the original appointment.

Chairman and vice chairman.

(c) The Board shall select a chairman and a vice chairman from among its members at the beginning of each Congress. The vice chairman shall act in the place and stead of the chairman in the absence of the chairman. The chairmanship and the vice chairmanship shall alternate between the Senate and the House of Representatives with each Congress. The chairman during each even-numbered Congress shall be selected by the Members of the House of Representatives on the Board from among their number. The vice chairman during each

Congress shall be chosen in the same manner from that House of Congress other than the House of Congress of which the chairman is a Member.

(d) The Board is authorized to sit and act at such places and times during the sessions, recesses, and adjourned periods of Congress, and upon a vote of a majority of its members, to require by subpena or otherwise the attendance of such witnesses and the production of such books, papers, and documents, to administer such oaths and affirmations, to take such testimony, to procure such printing and binding, and to make such expenditures, as it deems advisable. The Board may make such rules respecting its organization and procedures as it deems necessary, except that no recommendation shall be reported from the Board unless a majority of the Board assent. Subpenas may be issued over the signature of the chairman of the Board or of any voting member designated by him or by the Board, and may be served by such person or persons as may be designated by such chairman or member. The chairman of the Board or any voting member thereof may administer oaths or affirmations to witnesses. Meetings. Subpena.

DIRECTOR AND DEPUTY DIRECTOR

SEC. 5. (a) The Director of the Office of Technology Assessment shall be appointed by the Board and shall serve for a term of six years unless sooner removed by the Board. He shall receive basic pay at the rate provided for level III of the Executive Schedule under section 5314 of title 5, United States Code. Appointment. Compensation. 83 Stat. 863.

(b) In addition to the powers and duties vested in him by this Act, the Director shall exercise such powers and duties as may be delegated to him by the Board.

(c) The Director may appoint with the approval of the Board, a Deputy Director who shall perform such functions as the Director may prescribe and who shall be Acting Director during the absence or incapacity of the Director or in the event of a vacancy in the office of Director. The Deputy Director shall receive basic pay at the rate provided for level IV of the Executive Schedule under section 5315 of title 5, United States Code.

(d) Neither the Director nor the Deputy Director shall engage in any other business, vocation, or employment than that of serving as such Director or Deputy Director, as the case may be; nor shall the Director or Deputy Director, except with the approval of the Board, hold any office in, or act in any capacity for, any organization, agency, or institution with which the Office makes any contract or other arrangement under this Act. Employment restriction.

AUTHORITY OF THE OFFICE

SEC. 6. (a) The Office shall have the authority, within the limits of available appropriations, to do all things necessary to carry out the provisions of this Act, including, but without being limited to, the authority to—

(1) make full use of competent personnel and organizations outside the Office, public or private, and form special ad hoc task forces or make other arrangements when appropriate;

(2) enter into contracts or other arrangements as may be necessary for the conduct of the work of the Office with any agency or instrumentality of the United States, with any State, territory, Contracts.

86 STAT. 800

or possession or any political subdivision thereof, or with any person, firm, association, corporation, or educational institution, with or without reimbursement, without performance or other bonds, and without regard to section 3709 of the Revised Statutes (41 U.S.C. 5);

(3) make advance, progress, and other payments which relate to technology assessment without regard to the provisions of section 3648 of the Revised Statutes (31 U.S.C. 529);

(4) accept and utilize the services of voluntary and uncompensated personnel necessary for the conduct of the work of the Office and provide transportation and subsistence as authorized by section 5703 of title 5, United States Code, for persons serving without compensation;

80 Stat. 499; 81 Stat. 190.

(5) acquire by purchase, lease, loan, or gift, and hold and dispose of by sale, lease, or loan, real and personal property of all kinds necessary for or resulting from the exercise of authority granted by this Act; and

(6) prescribe such rules and regulations as it deems necessary governing the operation and organization of the Office.

Recordkeeping.

(b) Contractors and other parties entering into contracts and other arrangements under this section which involve costs to the Government shall maintain such books and related records as will facilitate an effective audit in such detail and in such manner as shall be prescribed by the Office, and such books and records (and related documents and papers) shall be available to the Office and the Comptroller General of the United States, or any of their duly authorized representatives, for the purpose of audit and examination.

(c) The Office, in carrying out the provisions of this Act, shall not, itself, operate any laboratories, pilot plants, or test facilities.

Agency cooperation.

(d) The Office is authorized to secure directly from any executive department or agency information, suggestions, estimates, statistics, and technical assistance for the purpose of carrying out its functions under this Act. Each such executive department or agency shall furnish the information, suggestions, estimates, statistics, and technical assistance directly to the Office upon its request.

Personnel detail.

(e) On request of the Office, the head of any executive department or agency may detail, with or without reimbursement, any of its personnel to assist the Office in carrying out its functions under this Act.

(f) The Director shall, in accordance with such policies as the Board shall prescribe, appoint and fix the compensation of such personnel as may be necessary to carry out the provisions of this Act.

ESTABLISHMENT OF THE TECHNOLOGY ASSESSMENT ADVISORY COUNCIL

Membership.

SEC. 7. (a) The Office shall establish a Technology Assessment Advisory Council (hereinafter referred to as the "Council"). The Council shall be composed of the following twelve members:

(1) ten members from the public, to be appointed by the Board, who shall be persons eminent in one or more fields of the physical, biological, or social sciences or engineering or experienced in the administration of technological activities, or who may be judged qualified on the basis of contributions made to educational or public activities;

(2) the Comptroller General; and

(3) the Director of the Congressional Research Service of the Library of Congress.

(b) The Council, upon request by the Board, shall— Duties.

(1) review and make recommendations to the Board on activities undertaken by the Office or on the initiation thereof in accordance with section 3(d);

(2) review and make recommendations to the Board on the findings of any assessment made by or for the Office; and

(3) undertake such additional related tasks as the Board may direct.

(c) The Council, by majority vote, shall elect from its members appointed under subsection (a)(1) of this section a Chairman and a Vice Chairman, who shall serve for such time and under such conditions as the Council may prescribe. In the absence of the Chairman, or in the event of his incapacity, the Vice Chairman shall act as Chairman. Chairman and Vice Chairman.

(d) The term of office of each member of the Council appointed under subsection (a)(1) shall be four years except that any such member appointed to fill a vacancy occurring prior to the expiration of the term for which his predecessor was appointed shall be appointed for the remainder of such term. No person shall be appointed a member of the Council under subsection (a)(1) more than twice. Terms of the members appointed under subsection (a)(1) shall be staggered so as to establish a rotating membership according to such method as the Board may devise. Term of office.

(e)(1) The members of the Council other than those appointed under subsection (a)(1) shall receive no pay for their services as members of the Council, but shall be allowed necessary travel expenses (or, in the alternative, mileage for use of privately owned vehicles and a per diem in lieu of subsistence at not to exceed the rate prescribed in sections 5702 and 5704 of title 5, United States Code), and other necessary expenses incurred by them in the performance of duties vested in the Council, without regard to the provisions of subchapter 1 of chapter 57 and section 5731 of title 5, United States Code, and regulations promulgated thereunder. Travel expenses. 80 Stat. 499; 83 Stat. 190. 5 USC 5701.

(2) The members of the Council appointed under subsection (a)(1) shall receive compensation for each day engaged in the actual performance of duties vested in the Council at rates of pay not in excess of the daily equivalent of the highest rate of basic pay set forth in the General Schedule of section 5332(a) of title 5, United States Code, and in addition shall be reimbursed for travel, subsistence, and other necessary expenses in the manner provided for other members of the Council under paragraph (1) of this subsection. Compensation.

UTILIZATION OF THE LIBRARY OF CONGRESS

SEC. 8. (a) To carry out the objectives of this Act, the Librarian of Congress is authorized to make available to the Office such services and assistance of the Congressional Research Service as may be appropriate and feasible.

(b) Such services and assistance made available to the Office shall include, but not be limited to, all of the services and assistance which the Congressional Research Service is otherwise authorized to provide to the Congress.

(c) Nothing in this section shall alter or modify any services or responsibilities, other than those performed for the Office, which the Congressional Research Service under law performs for or on behalf

of the Congress. The Librarian is, however, authorized to establish within the Congressional Research Service such additional divisions, groups, or other organizational entities as may be necessary to carry out the purpose of this Act.

(d) Services and assistance made available to the Office by the Congressional Research Service in accordance with this section may be provided with or without reimbursement from funds of the Office, as agreed upon by the Board and the Librarian of Congress.

UTILIZATION OF THE GENERAL ACCOUNTING OFFICE

SEC. 9. (a) Financial and administrative services (including those related to budgeting, accounting, financial reporting, personnel, and procurement) and such other services as may be appropriate shall be provided the Office by the General Accounting Office.

(b) Such services and assistance to the Office shall include, but not be limited to, all of the services and assistance which the General Accounting Office is otherwise authorized to provide to the Congress.

(c) Nothing in this section shall alter or modify any services or responsibilities, other than those performed for the Office, which the General Accounting Office under law performs for or on behalf of the Congress.

(d) Services and assistance made available to the Office by the General Accounting Office in accordance with this section may be provided with or without reimbursement from funds of the Office, as agreed upon by the Board and the Comptroller General.

COORDINATION WITH THE NATIONAL SCIENCE FOUNDATION

SEC. 10. (a) The Office shall maintain a continuing liaison with the National Science Foundation with respect to—

(1) grants and contracts formulated or activated by the Foundation which are for purposes of technology assessment; and

(2) the promotion of coordination in areas of technology assessment, and the avoidance of unnecessary duplication or overlapping of research activities in the development of technology assessment techniques and programs.

Scientific programs, financing.

(b) Section 3(b) of the National Science Foundation Act of 1950, as amended (42 U.S.C. 1862(b)), is amended to read as follows:

82 Stat. 360.

"(b) The Foundation is authorized to initiate and support specific scientific activities in connection with matters relating to international cooperation, national security, and the effects of scientific applications upon society by making contracts or other arrangements (including grants, loans, and other forms of assistance) for the conduct of such activities. When initiated or supported pursuant to requests made by any other Federal department or agency, including the Office of Technology Assessment, such activities shall be financed whenever feasible from funds transferred to the Foundation by the requesting official as provided in section 14(g), and any such activities shall be unclassified and shall be identified by the Foundation as being undertaken at the request of the appropriate official."

84 Stat. 1561; 82 Stat. 365. 42 USC 1873.

ANNUAL REPORT

SEC. 11. The Office shall submit to the Congress an annual report which shall include, but not be limited to, an evaluation of technology assessment techniques and identification, insofar as may be feasible, of technological areas and programs requiring future analysis. Such report shall be submitted not later than March 15 of each year.

APPROPRIATIONS

SEC. 12. (a) To enable the Office to carry out its powers and duties, there is hereby authorized to be appropriated to the Office, out of any money in the Treasury not otherwise appropriated, not to exceed $5,000,000 in the aggregate for the two fiscal years ending June 30, 1973, and June 30, 1974, and thereafter such sums as may be necessary.

(b) Appropriations made pursuant to the authority provided in subsection (a) shall remain available for obligation, for expenditure, or for obligation and expenditure for such period or periods as may be specified in the Act making such appropriations.

Approved October 13, 1972.

LEGISLATIVE HISTORY:

HOUSE REPORTS: No. 92-469 (Comm. on Science and Astronautics) and
No. 92-1436 (Comm. of Conference).
SENATE REPORT No. 92-1123 (Comm. on Rules and Administration).
CONGRESSIONAL RECORD, Vol. 118 (1972):
Feb. 8, considered and passed House.
Sept.14, considered and passed Senate, amended.
Sept.22, Senate agreed to conference report.
Oct. 4, House agreed to conference report.